THIRTY-SIXTH ANNUAL REPORT

FOR THE CALENDAR YEAR 1946

- Northern -
Rocky Mountain
Forest & Range
Experiment Station
Missoula Montana

Chas. L. Tebbe, Director

NOT FOR PUBLICATION

TABLE OF CONTENTS

	Page
Introduction	1
Division of Silvicultural Research	6
Division of Forest Economics	11
Forest Utilization Service	19
Division of Fire Research	25
Division of Range Research	32
Division of Forest Wildlife Investigations	42
Finances	44
Publications	46
Personnel	50
Status Sheets	52

INTRODUCTION

This is the 36th annual report of the Northern Rocky Mountain Forest and Range Experiment Station. Thirty-six years represent two-thirds of the life span of the states in our region, and they have witnessed a period of phenominal development and use of forest and range resources. Some of our experimental areas and plots are among the oldest in the land, and hence extremely valuable. The 500 publications by members of this station constitute a major contribution to the literature and practice of forest and range management. The present personnel of the station have a rich heritage, but we are positively humble before the size and complexity of the job that lies ahead.

In timber management for example, there is a spectacular increase in the need for information on cutting practices that will maintain and increase the productivity of forest land. Much work has been done in this field, but principally in the white pine type where the greatest values are, and where traditionally the greatest cut has been made. But even in the white pine type, the outbreak and spread of blister rust has called for abandonment of old management practices and the initiation of new ones.

Moreover, the volume of timber cut in the region has risen sharply in recent years. The volume of all timber cut has nearly doubled, and that on national forests in the last 5 years is up over 200% above the previous 5-year average. It is destined to go much higher - quickly. Hitherto little-used species such as are found in the larch-fir mixture are now sought after. Lodgepole pine has become attractive to Lake States pulp plants and to the local pole, post and lumber industry. Second growth ponderosa pine is being cut - much of it prematurely. These remarkable changes are war-born developments. They have come swiftly during a time when research was at its lowest ebb, and we are now hard pressed to furnish needed guidance. Time was when a sale of lodgepole or mixed timber was a cause for rejoicing. It was like selling a white elephant, and it mattered little how it was cut - the volume was so small. But now that it is big business and everyday business, the method of harvesting is much more consequential. The Division of Silvicultural Research is challenged, and must regain the lead that it has lost.

In fire control, the situation differs only in detail. For years, research recommendations were far ahead of application on the ground. But in this region administrators have now caught up and have been forced by the advent of new equipment, aerial delivery of men and supplies, extensive road development, diminished labor reserves, increased slash, and other factors to depart from early research-born principles of determining strength and distribution of forces, plan of attack, preparedness and strategy.

Administrators are making changes on the basis of judgment and estimates and guesses without benefit of research analysis. The program is too big, the expenditures too large, and the stakes too high to be safeguarded by such tactics.

Establishment of the Forest Utilization Service, now in its second year, was a timely development. During 1946 some 200 new sawmills were established in the region. There are 15 new pole processing plants, numerous pulpwood operations and other primary and secondary wood-using industries. Some of these have been encouraged and helped in getting started by the FUS. Most of them were unfamiliar with the characteristics of local species. Invaluable information on suitability for various purposes, machining characteristics, seasoning properties, resistance to decay, and strength and related properties has been made available. The FUS is in a key position to guide the establishment of future operators, and to help them avoid the pitfalls usually encountered in the processing and marketing of hitherto little-used species. Our lodgepole pole and pulpwood industries, already big but still in their infancy, must be safeguarded against the damage that could result from shipping material unsuited to those purposes. Close watch is being maintained over this. Increased production entails more mill and woods waste, and its chemical utilization for useful products including wood molasses and high protein yeast for livestock feed is in the forefront of our thinking and action.

The Division of Forest Economics has a big job on its hands. Currently the task of completing the forest survey looms largest. To determine what we have, where it is located, who owns it, the rate of growth and depletion, etc.; and to keep these records current is a big physical job and will continue to require substantial manpower and field work. The forest survey will provide the tools for doing an effective job of resource management. It is a means to the end of more intelligent planning, and to an appreciation of the role this region's forest resources can and will play locally, and in a nation whose forest products requirements are ever harder to supply from the depleted forests of older producing regions.

The Division of Forest Economics was established during 1946. It would have been nice to have a few years' advance study of the problems incident to new industrial development. But had that been the case a good deal of it would have been hypothetical. As it is, the development and the analytical work of the Division will proceed together with fullest opportunity for mutual benefit.

Range management research has a crucial role to play. Major adjustments in the pattern of agricultural production are essential before wartime price supports expire in 1948. This is especially true in the northern Great Plains area, where wheat

acreage expanded so greatly during war years. Few alternative crops are suitable for these semiarid plains. Fortunately the know-how for converting wheat or other semiarid cropland to grassland, for which the Northern Plains is so well adapted, has been substantially developed as compared with the situation at the close of World War I. One essential step toward greater stability is to have this reseeding program start promptly before noxious weeds take over to increase costs. The forage is needed for livestock near peak numbers.

Range reseeding research should be pressed more aggressively to round out information now available on methods, species adaptation and mixtures. Another step is to encourage balanced production of crested wheatgrass seed and of other suitable species. These steps should be supplemented by an adequate program of range extension to provide guidance to landowners and managers who must do the actual reseeding.

Better management of ranges is another essential for greater stability of the livestock industry. Ranges of the Northern Plains are now carrying close to the peak number of livestock that proved so disastrous during drought years of the last decade. Better distribution through more water developments and better herding would help equalize the pressure. Better feed reserves are also needed for drought years and for insect invasions. Best management practices - time of use, and rate of stocking, etc. - are not known for about 1½ million acres of range land in Montana alone plus a large additional acreage in adjacent states of the northern plains that have been reseeded during the past decade. If the area reseeded increases to the full extent desirable, the need for management guides will multiply accordingly.

The need for better management on millions of acres of native ranges is also urgent. Erosion, floods, and siltation are increased by overgrazing and mismanagement. Heavy grazing on relatively flat range reduced the depth to which rainfall penetrated soil, and materially slowed the rate of penetration of water applied by hand, as compared to similar soil across the fence on moderately-grazed short-grass range at Miles City. Even a small increase in storage of water in the soil would amount to a great total for the 130 million acres of Northern Plains range. The reduced erosion and increased production of forage with such additional storage can only be surmised because data are lacking for other plains soils. A satisfactory factual basis for guidance is lacking also in management of foothill and mountain ranges that furnish much of the runoff for the Missouri and Columbia River systems.

The Northern Rocky Mountain region straddles the headwaters of the two largest proposed river developments in the country. Dams and irrigation, power and navigation, are featured in great plans for the Missouri and Columbia River Basins. The success and

permanence of such wealth-producing enterprises depend in large measure upon the stability of soil in water source areas, its rate of infiltration, and water-holding capacity. These are factors over which land managers can effect great changes for better or worse, depending on what they do to forest and grass cover types. In the Northern Rocky Mountain region, these considerations have received all too little attention on private lands, and even public foresters have considered their down stream responsibilities well discharged if they kept the upper country green and free of fire and overgrazing. The favorable effect of forests on watersheds is well known, and to keep them green was to play safe. It was about all that could be expected during the period when vast forest resources were awaiting development.

But now the picture has changed. These "watershed forests" are being cut. There is public concern and in some quarters resentment over what appears to be a violation of long taught doctrine. The foresters themselves are uneasy because they do not know the effect of soil and cover disturbance on the quantity and quality and flow of water into reservoirs and irrigation canals. They cut the trees with an eye to reproduction but they are in the dark insofar as water influences are concerned. Alternative cutting practices might be just as good silviculture and might make a world of difference to down stream water users. This is just one illustration. In this dry country precipitation is mostly in the form of snow at higher elevations. The rate of snow melt in the spring governs the seasonal flow of water. We know forest cover affects the quantity of snow stored and rate of snow melt, but how much we gain or lose when we cut the timber is a matter of conjecture. Earnest effort is being made to consider forest influences in timber disposal plans, but resource managers are confronted on every hand with a pitiful lack of knowledge.

This leads to the point of this discussion. There is not and never has been a forest influences division in the Northern Rocky Mountain station. In view of our strategic location astride the headwaters of these two major river systems, this seems incongruous. Several men at the station are more or less informed on certain aspects of influences work - they were obliged to get into it in connection with their various projects. But no one is devoting full time to it. No one is in a position to tackle the everyday influences problems posed by resource managers. This situation must be corrected.

* * * * * * * * * * * * * * * * *

The above is a thumbnail sketch of the research responsibilities of this station. It is a big program but would appear even bigger than it is except for the overall general competency of the 25 professional foresters who comprise the staff. Although all divisions could give value received for a larger budget, the

Division of Fire Research is most out of balance with needs and opportunities. The lack of a forest influences program is a glaring omission.

The following pages present a review of recent accomplishments and plans for 1947. They are designed for easy reading - underscored topic sentences for the person in a hurry - followed by more detail if you are interested. Your advice and comments are solicited and will be greatly appreciated.

DIVISION OF SILVICULTURAL RESEARCH

A. Accomplishments in 1946

(1) Timber cutting practices were emphasized. Information on cutting practices continued to be the most urgent need in the field of forest management. The accelerated program of timber cutting, the increasing use of larch, Douglas-fir, and lodgepole pine from both private and public timber lands, and the general distribution of white pine blister rust make it imperative that the best knowledge and skills be employed in managing timber cutting operations. The station gave first priority to these problems.

Revised instructions for marking in the western white pine type were prepared and given to the Division of Timber Management. The Division of State and Private Forestry is distributing copies to white pine operators. The revision is decidedly more complete and specific than previous instructions. It contains separate rules for several conditions and ages of stands. It also presents the latest information on how to assist in blister rust control by (1) regulating the overstory to devitalize ribes seed stored in the soil and suppress young ribes plants, and (2) using prescribed burning to destroy seeds and bushes.

A 3-day meeting for timber management staffmen was held on the Deception Creek Experimental Forest. Experiments and demonstrations of white pine cutting methods were viewed and discussed. Cooperators from the Office of Blister Rust Control and Forest Insect Laboratory took part in order to explain how blister rust and insect control can be correlated with cutting practices.

Ribes control through silvicultural operations requires that certain degrees of shade be maintained after partial cutting. A Research Note was prepared which gives tables for estimating the light intensity after partial cutting.

A tract of ponderosa pine which was cut selectively 35 years ago was examined in detail to learn how growth and reproduction had responded. The analysis is not yet complete, but it appears the findings will largely bear out the results of similar studies in the ponderosa pine type in other regions. If it is found that results of research in other regions are applicable here, local cutting practice recommendations can be modified accordingly.

The tendency for Douglas-fir to invade and crowd out ponderosa pine reproduction is more acute in this region than elsewhere. It is likely that special measures such as seed-bed preparation

by scarification or burning, and subsequent cleanings will be needed to keep ponderosa pine well represented in future stands. Damage to ponderosa pine reproduction by deer browsing is being appraised and studied by a Fish and Wildlife Service cooperator.

Timber sales in the lodgepole pine type were visited and marking rules were examined. Suggestions on the soundness of the practices and ways for improving them were given where possible.

(2) Stand improvement studies were summarized and reported. Only about 1/3 of the live crown of western white pine can be removed in pruning without causing a substantial loss in growth. This was reported in a Research Note for the information of timberland owners, extension foresters, and forest managers. Another Research Note described the results of an experiment designed to show how to prune trees and the proper kinds of ponderosa pine and white pine trees to select for pruning. Best results are obtained by pruning small live branches on rapidly growing trees.

The best time to improve the species composition of young stands of white pine is after dominance has been established. To undertake cleanings or weedings earlier is likely to be a waste of money. This information was published in a Research Note.

(3) Initial phase of direct seeding project was completed. Direct seeding can be a useful alternative to planting nursery-grown trees on selected sites when greater flexibility is needed in the planting program. However, it is not likely to replace planting over the major areas in need of reforestation at present. The best initial establishment was about equal in success to planting trees and the costs were lower, but early growth was slower. The most favorable sites for direct seeding are north slopes and flats in the western white pine type which have been freshly burned. Protection from rodents by poisoning or screening the seeds spots is essential. These are the highlights from the direct seeding study started by the station nine years ago. Several Research Notes have been released. A manuscript for a Department publication has been prepared, revised after review, and is now in the hands of the editor in the Washington office.

(4) The Western Montana Work Center was organized. A new work center was organized in western Montana during August and September as the result of appropriation of funds for this project by Congress. Earlier research in silviculture at the Northern Rocky Mountain Station was largely directed to the western white pine type in northern Idaho because of limited funds and the greater economic importance of the white pine type. The increasing utilization of Montana timber recently has given rise to greater demand for knowledge on how to manage

Montana timber types. The study of the old selective cutting in Lick Creek, described earlier, was the only major study started during 1946. Headquarters for the new work center is at Missoula, Montana.

B. Plans for 1947

(1) Expand cut-over area studies to include larch-Douglas-fir type. Examination of cut-over areas in the larch-Douglas-fir and ponderosa pine types is planned. The purpose is to gather information upon which to base recommendations for cutting practices. Many conditions and ages of stands will be observed.

Experience gained on the Lick Creek study in 1946 will be used as a guide in planning methods for the survey, but the type of study will be altered to cover many areas quickly instead of one tract in detail. Observations and measurements will include data on composition of original stand, intensity of cutting, growth and mortality of residual trees, kind and amount of reproduction, and any particular factors which seem to have affected the results.

It is expected that it will be found possible to tie in research results on ponderosa pine from other regions. The larch-Douglas-fir type, on the other hand, has not been studied intensively, either here or elsewhere. Therefore, progress in developing cutting recommendations will be slower.

One set of ponderosa pine harvest cutting experiments will receive its third 5-year remeasurement. The results will be analyzed and reported during the winter of 1947-48.

(2) Continue partial cutting studies in the white pine type. One new test of partial cutting in a mature stand and one in an immature stand will be established on timber sales during 1947, in order to continue rounding out a program of plots commenced several years ago. The objects of these studies are to determine (1) the classification of white pine trees as an aid in tree selection for partial cutting, (2) more specific information on the effect of partial cutting on insect and blister rust control, and (3) growth responses following partial cutting. Existing plots are inadequate in numbers and too restricted in location to supply generally applicable information.

Growth and mortality data from three groups of plots in mature stands and one in an immature stand will be analyzed and reported.

(3) Give advice and guidance on timber management practices. The station will continue to give advice and guidance on timber management practices to all interested individuals and organizations. Specific services which have already been planned include the following:

(a) Furnish Montana Extension Forester with information on harvest cuttings, stand improvement measures, and propagation of Christmas trees.

(b) Provide information for the special study of blister rust control policy. This will include preparation of an emperical yield table for prediction of growth of stands under different levels of management.

(c) Assist in revising marking rules for lodgepole pine and larch-Douglas-fir. Larch-Douglas-fir type will be made the subject of cut-over area surveys mentioned earlier. It is regretted that similar studies cannot be undertaken in the lodgepole pine type, but available facilities will not stretch that far. However some assistance will be given in the lodgepole type by aiding national forest personnel in conducting local studies of old cuttings, and giving advice based upon review of literature and general experience.

(d) A handbook section of instructions for stand improvement measures on National Forest timber sale areas will be prepared. After this has been completed, consideration will be given to preparation of a more general publication for use by farm and other private foresters.

(4) Continue stand improvement studies. A report on the rate and manner of disintegration of girdled hemlock trees will be prepared as a Research Note.

Several thinning and pruning plots will be remeasured. It is too soon to anticipate the findings.

One test of poisoning, one cleaning experiment, and three demonstrations of pruning will be established.

(5) Round up information on Christmas tree management. More than 3 million Christmas trees were cut in Montana in 1946. Production has more than doubled in the past decade. It is doubted that this important forest industry can be held at the current level unless management practices are improved. During the current year, information in the files of Timber Management and the station will be compiled, and a limited amount of field work may be undertaken for the purpose of preparing recommendations on Christmas tree cutting practices.

(6) Put direct seeding experiments on maintenance basis. With the completion of the initial germination and establishment phase, the direct seeding plots will be measured only at 5-year intervals to determine growth, stocking, and possible need for thinning.

(7) Continue stand studies on maintenance basis. The station has many growth plots which are becoming increasingly valuable with the passage of time. Work will be limited to periodic remeasurements until it becomes possible to make a thorough compilation and analysis of the results. An empirical white pine yield table will be prepared for use in the special study of blister rust control policy.

(8) Prepare a problem analysis for Western Montana Work Center. A problem analysis for the Western Montana Work Center has been started. It is planned to complete this and a plan of work. A brief and more hastily drawn-up analysis made last year has been used to date because it is apparent that the most important problems have been identified. However, it is recognized that a more detailed and complete plan is needed for use over a longer period.

(9) Hold meeting for state and private foresters at Deception Creek. A timber management meeting will be arranged at Deception Creek for representatives from state forestry departments, timber industry associations, forestry schools and timber companies. Cutting and regeneration practices for the western white pine type will be featured. Two or three days will be required for the program.

DIVISION OF FOREST ECONOMICS

A. Accomplishments in 1946

(1) Organization of a Division of Forest Economics was approved May, 1946. In recognition of the growing importance of the economic phases of forestry and to consolidate projects, primarily economic in scope, which were in other divisions, the Station received approval for the establishment of a Division of Forest Economics. This division absorbed the work of the Forest Survey and took over a number of the projects previously carried on by the Division of Forest Products. The work program was grouped in four sections: (1) forest survey inventory and statistical procedures, (2) forest resource analysis, (3) forest industry analysis and (4) economics of management and utilization.

To carry out work programs seventeen positions were designated and staff recruitment started in July. Four men were from the Forest Survey, two transferred from projects in the Region and two from other regions, two new appointments were made from the Civil Service register, and two clerks were assigned from other positions. Due to delays in selecting a division chief, a staff member from the California Station was assigned here temporarily until October, when the position was filled. This completed the organization of the Economics Division within the limitation of appropriated funds.

(2) Reappraisal of the forest situation, initiated in 1945, was completed early in 1946 by Forest Survey personnel. Completion of the allowable cut section of the Reappraisal Report was delayed until 1946 because of adjustments and recalculations, resulting largely from the exploratory character of the study. This project attempted to determine for the reappraisal region and for several subregions: (1) the future annual yield objective under intensive management, (2) the allowable annual cut to achieve the objective under three suppositions, (3) the growing stock needed to maintain the future annual yield objective, (4) the growing stock needed to maintain the 1941-42 sawtimber cut, (5) the growing stock 20 years hence under the prevailing cut and (6) the sawtimber cut that can be maintained from the existing level of growing stock.

Findings for the entire reappraisal region -- Idaho, Montana, Wyoming and the Black Hills portion of South Dakota -- by designated items were:

	Sawtimber and Pole Trees	Sawtimber Trees Only
	MM Cu. Ft.	MM Bd. Ft. (Lumber Tally)
1. Annual yield objective	651	1,855
2. Allowable cut 1945-49 to achieve objective		
(a) If necessary adjustments are made immediately	-	1,856
(b) If adjustments are made after 5 years of cutting at the 1941-42 rate	-	1,771
(c) If adjustments are made with the least disruption of local industry	-	1,856
3. Growing stock needed to maintain yield objective	24,923	46,696
4. Growing stock needed to maintain 1941-42 drain	25,581	45,957
5. Growing stock 20 years hence under prevailing drain - 1941-42	31,343	118,687
6. Annual sawtimber cut that can be maintained from existing level of growing stock	-	1,856

(3) Reporting on factors affecting log and lumber production continued throughout the year. Twelve monthly reports summarizing and commenting upon the production outlook and indicating the relative significance of all factors impeding maximum production of lumber were prepared. Originally designed to assist the War Production Board in appraising the lumber situation, this project was continued in the postwar period for the Civilian Production Administration, successor to W.P.B.

During the first quarter of 1946, these reports emphasized that regional lumber production was down about 25 percent compared to the previous year because of the prolonged A.F.L. strike. In April, however, with the strikes over, a marked improvement in production was indicated and by August production reached the highest point recorded in recent years. By then it appeared

that 1946 production might equal that of 1945 in spite of the near disastrous first quarter period. But to some extent the favorable conditions of the second and third quarters were offset by poor weather in October and November. Heavy fall rains and early snow cut down log production and resulted in premature closing of some large sawmills. Manpower, which for more than two years had been a major factor limiting production, eased in November and some surplus was reported. In the closing weeks of December it was clear that 1946 lumber production would exceed 1945 by a slight margin.

Changes in personnel, four different men being assigned to this project in 12 months, and uncertainties as to continuation of the project made continuity and high quality work difficult.

(4) A study for the Bonneville Power Administration to be used as a basis for gaging future power requirements of forest industries was continued and completed. Since predicting future levels of employment, production and power requirements in forest industries depend to a large degree on full knowledge of forest resources, the major part of this study involved interpretation and projection of forest survey statistical data. Much of the necessary background information had previously been compiled in the reappraisal study.

Analysis of past and probable future production for both primary and secondary wood using plants showed that in the period 1955-65 about two billion feet of timber could be cut in northeastern Washington, Idaho and western Montana. However, because of the lack of adequate road systems, of the distance of plant capacity from the timber, and of the unfavorable cost-price relationship for many species, production is unlikely to exceed 1.5 billion feet and may even be as low as 1.0 billion feet. On the basis of an annual production of 1.5 billion feet, employment during 1955-65 might reach 19,300, while on the lower figure of 1.0 billion feet, employment would be down to about 12,700. From the detailed information of probable future production by major industry groups power requirements may be derived.

(5) Production statistics for lumber, lath, shingle and cross ties were collected and compiled in cooperation with the Bureau of Census. Statistics for these items for 1945 were solicited from over 700 sawmills. To get complete and accurate data direct field contacts with nearly half of the individual producers were required. A special effort was made to locate new sawmills and to delete incorrect listings. Each production report was edited by the station and forwarded to the Bureau of Census.

Preliminary compilations of edited reports showed there were 455 active and 206 idle sawmills in Region 1 in 1945. These mills produced 1,094,424,000 ft. b.m. of lumber, a decrease of

14 percent from 1944. In addition production of about 21½ million pieces of lath and 25½ thousand squares of shingles was reported.

Data on prices and volume of stumpage and logs were collected and compiled along with the census of lumber production. This survey, omitted the previous year, followed a plan proposed by the Washington office. Due to resignations, and organizational changes preliminary tabulations of data were not scheduled for release until 1947.

(6) Preparation of a ten-year plan for maintaining and finishing the initial phase of the forest survey was completed. With substantial funds once again available for forest survey work, detailed plans were made for completing the initial phase of the survey in eastern Montana and for starting a ten-year program for maintaining survey work previously done. Prior to 1946 all of the region west of the Continental Divide and four counties in eastern Montana had been covered by detailed inventory and growth studies. In accordance with the new objective of keeping the survey up to date a comprehensive plan was made to resurvey the areas previously worked. Because the funds available for this purpose were much less than allocated for the initial survey, a sampling method was adopted. During the summer various sampling procedures were tested. The design finally selected calls for inventorying a cluster of three one-fifth-acre plots at locations spaced four miles apart. Under this arrangement it is now planned to re-inventory the region in ten years.

The plan for completing the initial survey in eastern Montana is similar in most respects to that adopted for the maintenance survey. With 10.4 million acres of forest land to be inventoried and mapped a plan was set up to finish field work in this subregion by 1950. A sampling method will be followed; the plot clusters will be spaced four miles apart on national forests and adjacent timbered areas that are covered by grazing survey maps, seven miles apart on areas covered only by aerial photographs and ten miles apart on areas covered by neither. Financial limitations prohibit using the same sampling intensity as is planned for west of the Continental Divide.

Office plotting of the locations for sample plots on county maps was well under way by the end of the year, 3,000 primary control locations for the maintenance survey and 1,000 of the locations for the initial survey had been spotted. Selection of aerial photographs for locations having forest cover was started for both surveys.

Field work in Cascade County, Montana was completed while new survey methods were being designed. Started in 1941, the survey in this county was not finished because of staff reductions

during the war. Approximately 21 townships were covered by the in-place method of mapping and inventorying in 1946.

Stevens County, Washington was the only area where the survey was finished on the new sampling method. Field work started during July and after several variations in spacing of plots and crew organization, the procedure was standardized and the inventory completed.

Statistics for Benewah County, north Idaho were brought up to date by office compilation. The survey field work was done in 1943-44 by taking 4000 1/20-acre plots at intervals of five chains along parallel lines spaced three miles apart. Compilation of the data was completed in 1946. Release of a statistical report is scheduled for 1947.

(7) Plans were made to standardize methods for calculating commodity drain. Following a meeting of western station representatives at Portland, standardized methods were proposed for collecting and compiling commodity drain statistics. Plans are to gather data on the cut of sawlogs for sawmills, pulpmills, shingle mills, and tie mills and of poles, piling and pulpwood annually in conjunction with the census enumeration of lumber and shingle mill production. Drain from other commodities, mine timbers, fuelwood, posts and hewn ties will be enumerated every five years. The cut of two items, fuelwood and posts, will be studied to design a sampling method for determining the total drain represented by these products. The volume of all other products will be collected by a 100 percent inventory, either by contacting producers or some intermediary as concentrators and consuming plants.

(8) A study of one of the most complex problems in the region, the economics of growing white pine under the handicap of blister rust, was undertaken by the Experiment Station and the Division of Timber Management of Region One. Two men, one from the office of Timber Management and one from the Division of Forest Economics of the Experiment Station, were assigned full time to the job. Additional help is being provided as needed by the national forests, the office of Blister Rust Control of the Bureau of Entomology and Plant Quarantine and by the Experiment Station. Plans are to complete the study by the end of 1947. We hope to come out with a clearer understanding of this complex situation and with a better basis for national forest policy insofar as white pine timber growing is concerned.

A combination of factors has made reconsideration of the situation urgently necessary. In the first place the rising cost of doing business has made blister rust control much more expensive than formerly. A day of effective blister rust control work cost three times as much in 1946 as it did a decade ago.

Moreover, control of the disease is turning out to be a much bigger job than originally supposed. These two factors raise the question of whether the present and potential values on some white pine areas are sufficient to justify the cost.

The rise in value of the secondary timber species during the war years brings up another important consideration. During the first four decades of the century the trees associated with white pine were for the most part a liability. White pine carried almost all of the lumber economy in the white pine belt of the Inland Empire. The picture changed during the war. But are these better prices of the last few years just a temporary flurry or have the secondary species really come into their own? Obviously the outlook for these species has direct bearing on the amount of blister rust control which is justified.

Simply stated the issue which must be reconsidered is: how much blister rust control work is justified by the present conditions and outlook? The study to arrive at the answer to this question is divided into four general phases, each of which is a subject in itself.

Past efforts to cope with the disease on the national forests are being evaluated and an attempt is being made to determine the present status of control. The latter task is not easy. Records kept thus far have mainly shown the number of currant and gooseberry bushes pulled annually, the man-days spent on such work, the acres covered and the cost. As most areas need to be covered at least three times, these statistics have failed to show the true status of the project. In this study we hope to get a better idea of the total size of the job in man-days and dollars, so we may say whether it is one-quarter, one-half or three-quarters completed.

An analysis will be made of the broad social and economic values involved in blister rust control. How much white pine might the Nation need in an economy of abundance? To what extent is white pine timber required to keep the future lumber economy of the Inland Empire on an even keel? Obviously no precise answer can be given to these questions. An effort will be made, however, to determine the full significance of these factors from the standpoint of white pine timber growing policies.

Attention will be directed to the costs and returns of timber growing. For the first time all of the costs which are involved in growing white pine will be added up and weighed against the values. If it does not seem desirable to utilize the full white pine growing capacity of the region, these cost calculations will provide a partial basis for determining in which drainages the white pine should be grown.

Out of our past experience with blister rust control, from a study of the dollars-and-cents aspect of timber growing, and from consideration of the national and regional needs for white pine we should be able to suggest whatever reorientation of national forest policy is desirable. Further than that we should be in a position to suggest the type and size of program required to carry out this policy.

B. Plans for 1947

(1) Organization - none.

(2) Reappraisal - project complete.

(3) Factors affecting lumber production - Present plans are to continue reporting monthly to the Civilian Production Administration estimates of lumber production and indicating significant factors which are influencing the production of lumber. The project is scheduled to terminate on June 30, 1947.

(4) Cooperation with Bonneville Power Administration - project complete.

(5) Cooperation with Bureau of Census - Arrangements have been completed with the Bureau of Census to conduct a similar survey in 1947. Much of the field work will be done in conjunction with commodity drain surveys.

(6) Forest survey - inventory and growth -

(a) Maintenance Surveys

1. Complete field examination of Pend Oreille, Ferry, Spokane, Lincoln and Whitman Counties in northeastern Washington.

2. Finish compilation of 1946 field data for Stevens County.

3. Commence compilation of data for northeastern Washington counties.

4. Locate control points on base maps and examine aerial photographs for selection of prints covering forested plots.

5. Revise statistics as of January 1, 1947, for the western Montana analytical report.

(b) Initial Surveys

1. Complete field examination of Pondera, Glacier, Toole, Liberty, Teton, Hill, Lewis & Clark, Meagher and Broadwater Counties in eastern Montana.

2. Commence compilation of data for counties inventoried.

3. Compile and release statistical report for Cascade County.

4. Locate primary control points on base maps and examine aerial photographs for selection of prints covering forested plots.

(7) Forest Survey - commodity drain - An investigation will be made of converting factors most commonly used in survey work. If the factors now in use are not based on reliable and comprehensive studies recommendations will be made for undertaking special work. In this investigation the Station will serve as a collating agent for the California and Pacific Northwest Stations.

Commodity drain for sawlogs used in lumber production will be collected in conjunction with the annual census of lumber production. Data on the production of sawlogs for tie mills, pulpmills, shingle mills and of poles, piling and pulpwood will be solicited by field contacts.

Methods for sampling post and fuelwood production will be investigated. It is proposed to follow in general a sampling procedure used by the Bureau of Census for the Census of Agriculture in 1945 and to relate fuelwood and post production to these data. This procedure will be studied in four counties, two in northeastern Washington and two in eastern Montana.

Logging waste resulting from commodity drain will also be investigated experimentally. This material represents nearly 25 percent of the total drain. Yet in the past no standardized procedure has been followed in arriving at the volume of waste which represents drain. A sampling method is being designed whereby the volume of waste will be measured on a number of plots on cutover timber land and related to the volume of the commodity removed.

(8) Economics of blister rust - project to be completed and report released.

A. Accomplishments in 1946

(1) Chemical analysis of western larch produced numerous useful products. This species has long been recognized as one of our richest chemical woods of the western conifers. It differs from other conifers in that it contains a much higher percentage of galactose sugar. While this sugar is found in the wood throughout the entire tree, the highest concentrations are found in the butt or stump portion of the tree. Variation of galactose in wood from butts, top wood (logging waste), slabs, and suppressed and intermediate trees was determined. About 20 percent of the dry weight of butt wood is galactose, contrasted to 12 percent in wood from limbs and the top half of the tree. Suppressed trees yielded only 7½ percent of their dry weight in galactose. Results of studies to date indicate the following products obtainable from one cord of wood from the butt portion of larch trees:

Lignin	1,050 lbs.	
Mucic acid	400 lbs.	
Ethyl alcohol	75 gals.	Wood sugar used for these two products can be converted to 480 pounds of fodder yeast or 240 gallons of wood-sugar molasses.
Fodder yeast	90 lbs.	
Gypsum	320 lbs.	

About 800 pounds of baking powder can be produced from the mucic acid which is derived from the galactose sugar. The remaining wood sugars can be fermented and distilled to alcohol and fodder yeast made from residual sugars in the still bottoms. Or these remaining wood sugars can be converted to 480 pounds of fodder yeast or 240 gallons of wood-sugar molasses suitable for stock feed.

To facilitate chemical utilization of larch, a survey was made of the volume of larch available in the form of long butts from previous logging operations. One source estimates that worldwide market conditions for mucic acid are such that the market would absorb the products from a plant using 500 to 1,000 cords of larch wood per day.

(2) Feeding studies to determine palatability to livestock of wood-sugar molasses were started. Molasses made from western larch and lodgepole pine at the Forest Service pilot plant in Madison, Wisconsin, was furnished the Montana Agricultural College, Bozeman, Montana. This is being fed under a variety of conditions to cattle and sheep. This material is much thinner than ordinary cane-sugar blackstrap molasses but contains 50 percent sugar.

(3) Possibilities of the substitution of western softwoods for basswood as a cross-banding and core material were determined. This work was done by the Underwood Veneer Company of Wausau, Wisconsin. Sample veneer logs of ponderosa pine, western larch, western white pine, and Engelmann spruce were selected and shipped to the company's Wausau veneer and plywood plant. Here under the observation of company representatives and technicians from the Madison Forest Products Laboratory numerous variations of veneer and plywood were produced. Results indicate that these woods are not a satisfactory substitute for basswood core stock and cross-banding where plywood is used for curved or molded products. However, flat plywood of excellent grade was produced. Larch panels using vertical-grain veneer cut by eccentrically chucking the logs resulted in some very interesting grain patterns.

(4) Pulping tests were made of lodgepole pine and western larch. Much valuable information has resulted from studies made during the year. It includes data on the pulping of dead lodgepole pine from the Philipsburg area in Montana. Green, rapid-growth lodgepole of high sapwood content gave the highest yield of pulp, or 46.5 percent of the dry weight of wood was usable pulp. Wood from dead standing and dead down material gave a pulp yield of 45.75 and 46.05 percent, respectively. The lowest yield, which was 43.5 percent, came from dead wolf trees.

Pulpwood shipments from Montana to Wisconsin continue. In 1946 over 750 carloads of 100-inch wood were shipped. This is a slight decline over 1945 which is attributed to uncertainty over a stable freight rate.

(5) Wood service tests form the basis for a new 3-3/4-million-dollar industry. The station has wood-service installations consisting of 31,000 telephone and power poles, over 1,000 stubs used in reinforcing poles, over 11,000 fence posts, more than 6,000 railway ties, and 184 mining timbers. The required annual inspections of these were made in cooperation with the Forest Products Laboratory.

Information on the service life of these species was furnished to approximately 200 inquirers during the year. These individuals and companies were either in production of poles or posts or were contemplating a new operation. Service records proved that lodgepole pine poles when satisfactorily butt-treated will last 25 years under semiarid conditions. These and other service records were part of the bulwark upon which a new pole industry in the northern Rocky Mountain area was built in the last 18 months. New processing plants in Montana featuring lodgepole pine are now located at Bozeman, Helena, Butte, White Sulphur Springs, Philipsburg, Hamilton, Kalispell,

Libby, Troy, and Arlee. Last year they produced 200,000 poles valued at 1½ million dollars. By the end of 1948 they should reach full production and turn out poles values at 3-3/4 million dollars.

(6) A plant for laminating mine guides is contemplated at Bonner, Montana. A mine guide is a high-quality band of wood used in the shaft of lode mines. It guides the cage carrying men and supplies down into the ground often to depths of more than 4,000 feet. Test installations in the Butte mines indicate that guides laminated from 1-inch western larch boards give service equal to or better than guides made from the highest grade Coast Douglas-fir. Inspection of used guides removed from service since the tests were started 2½ years ago indicates no cases of failure due to faulty glue bonds.

The lumber department of the Anaconda Copper Mining Company is now doing the exploratory engineering work preliminary to installation of a laminating plant at the company's Bonner, Montana, operation.

(7) Strength properties of western larch transmission poles were found comparable to southern pine. During the year larch wood from pole-sized trees were tested at the Forest Products Laboratory. Test material was procured from three localities viz, Newport, Washington, and Thompson Falls and Libby, Montana. The average of this material constituted a good cross-section of the western-larch-producing area. Each shipment consisted of five 16-foot sections, three from trees that would produce one 30-foot, one 40-foot, and one 45-foot pole, respectively; and two from trees that would produce one 35-foot pole each. Laboratory tests showed that a considerable quantity of the test material developed a modulus of rupture of 8,600 pounds per square inch which is comparable to southern pine.

(8) A variety of activities resulted in a better public appreciation of the use of wood. Several individuals and parties of men were guided around the region to observe wood-utilization practice. Amongst them were (a) manufacturers interested in the use of local woods for veneer and plywood, (b) individuals interested in establishing new transmission-pole and post processing plants, as well as (c) representatives of foreign governments such as Kai Wang, forest products engineer of the Chinese government.

A forest products exhibit featuring wood products of the northern Rocky Mountain area was developed in cooperation with the Forest Products Laboratory and the regional forester. It was shown widely through Montana, Idaho, and eastern Washington. Many requests for a showing of this exhibit were received that could not be filled, one from Tampa, Florida.

Members of the F.U.S. staff helped organize and participated in a Wood Products Clinic at Spokane, Washington. Some 150 members of the wood-using industries of the Inland Empire participated in panel discussions on problems pertaining to (a) wood waste, (b) the round-timber industry, and (c) the wood-remanufacturing industry. Perfection of a permanent organization is contemplated. Objectives of this organization are to:

(a) Develop public and industrial recognition of wood as an industrial material, thereby advancing the wood-using industries to their proper niche in respect to other industries.

(b) Promote better utilization of wood by existing wood-using industries and develop new uses for wood by affording an opportunity for interested individuals to meet regularly and discuss equipment, raw material supply, production, marketing, and other problems common to wood users.

Members of the F.U.S. staff also made an extensive tour of the wood-using industries of western Washington and Oregon to determine what processes and practices might be established as new industries in the northern Rocky Mountain area or used to improve local industries.

B. Plans for 1947

(1) The work program of the Forest Utilization Service is twofold. Much of the research work is done at the Madison Forest Products Laboratory, and the field F.U.S. unit puts research results to work for industry. Many of the research projects as well as application of research results are continuing in nature hence are carried forward from year to year.

(2) Research projects at the Forest Products Laboratory are so designed as to facilitate accomplishments of the following objectives:

(a) Establishment of a pole and post industry that is compatible with local forest management needs and integrated with the existing cedar pole and other wood-using industries.

(b) Expansion of a fibreboard industry to northern Idaho and western Montana, and completion of pulping tests on local species.

(c) Establishment of a chemical industry in the region using wood as a raw material.

(d) Establishment of a plywood industry integrated with the lumber and fibreboard industry using western larch and other local species.

(e) Establishment of a wood-laminating plant to serve the needs of the region.

(f) Betterment of existing wood-using industries and development of new secondary wood-using industries to create new payrolls for an increasing population.

(3) Many jobs must be undertaken by the local F.U.S. to accomplish these objectives. The more important are:

(a) Arrange for livestock feeding of wood-sugar molasses.

(b) Determine suitable location for fodder-yeast or molasses pilot plant.

(c) Develop facts basic for yeast and molasses production and present to interested individuals and agencies.

(d) Arrange for tests by local agricultural colleges of lignin as a soil conditioner.

(e) Guide and rearrange program to most effectively ward off possibility of the use of lodgepole pine for poles, pulpwood, and other products coming into bad repute because of inadequate specifications and utilization practices.

(f) Continue efforts to develop suitable moisture meter for round-timber industry.

(g) Encourage new service test installations of pentachlorophenol treatments.

(h) Survey wood waste supply at two or three logical board-plant sites (suggested locations: Hamilton, Kalispell, Spokane, and Coeur d'Alene), procure samples, and furnish Laboratory with a report showing the various amounts of waste available.

(i) Develop possibilities of a fibreboard pilot plant in the Spokane area - finances, etc.

(j) Develop possibilities of use of Engelmann spruce as a box type of veneer.

(k) Continue liaison with Underwood Veneer Company, Wausau, Wisconsin, on use of local species for veneer.

(l) Cooperate with J. Neils Lumber Company, Libby, Montana, to determine possibility of integrating veneer and plywood industry with their operation.

(m) Assist in procurement of funds and help construct experimental dry kiln at the University of Montana Forestry School.

(n) Encourage and promote new sawmill equipment suitable for small timber, especially lodgepole pine.

(o) Develop uses for waste resulting from pole industry.

DIVISION OF FIRE RESEARCH

A. Accomplishments in 1946

(1) Fire Control Planning Research Resumed. Major changes in the fire problem of the northern Rocky Mountain region have become significant in the past few years. The National Forest fire control organization also has now tested most of the principles of planning the distribution of facilities and the operational procedures developed by our research of 1931 to 1936. The need has become obvious for thorough analysis of the recent fire load, new values at stake, changed fuel types, a detection system beginning to be antiquated by new roads and by airplanes, loss of CCC, WPA, and military reserve manpower, the development of inter-agency fire control, and other features.

Preliminary principles to guide the allocation of fire control facilities and manpower, initiated by research of 10 to 15 years ago, can now be developed much further and materially modified in some respects. To commence this work J. S. Barrows, formerly Fire Training officer in the National Park Service, was engaged as Project Leader. Barrows' experience in fighting fires in nearly all parts of the U. S., together with his military service of three years on aerial bombing strategy and tactics in the Pacific theatre, fit him remarkably well for this job. After several months of personal examination of present conditions and practices Barrows prepared a detailed Working Plan to guide this research.

Machine compilation of the 25,000 punch-carded fire reports for the National Forests is already well under way. Compilation of these data to answer several urgent questions confronting the Regional office of Fire Control is in progress. Results will be made available as rapidly as one man can do such work without clerical assistance.

(2) Aerial Bombing Preparations Made. Tests of the long and publicly advocated possibilities of bombing fires with either water or chemicals were commenced in July 1946. This project, initiated by national Fire Chief D. P. Godwin with cooperation from the Army Air Forces, was assigned to this region. Two other aerial experiments are already under way here; our field and supervisory personnel are familiar with many of the possibilities as well as limitations of aerial protection; and Barrows' experience in the AAF supplied the essential background for most effective cooperation with the military. Barrows spent about two months on this work before lack of wing racks and other technical difficulties caused the Army to return the work to Eglin Field, Florida, the technical base. Whereas only one B-17 plane was used in 1946, indications are that two planes and crews will be available in 1947. Preparations for thorough control of all tests have been completed in a target area not far from Missoula.

(3) Fire Danger Measurements Tested . Testing of the accuracy and dependability of any fire danger meter is as difficult as the development of such a device. Ultimately, tests by both experienced opinion and measured rate of spread of fire in various fuel types under different weather conditions, must be made. No measured tests have been possible since 1939 to 1941 when 87 fires were set and their fire spread measured. The results of these tests emphasized the close inter-relation of fuel type classification and danger class. They also furnished data used in developing the Model 5 Danger Meter into Model 6, issued in 1942.

Tests of the Model 6 meters, comprising separate devices for rating Burning Index and Danger Class, have necessarily been confined to experienced opinions. These are being assembled by means of a questionnaire prepared jointly by the Regional office of Fire Control and the Division of Fire Research. Scientific conclusions will not be possible until four requirements can be met: (1) critical burning conditions occur again, (2) field measurements are made with uniform accuracy at all stations, (3) the Burning Index is judged only by fire behavior on exposures similar to neighboring danger stations, and (4) Danger Class is judged separately from the danger class-manpower curve, which specifies the percentage of manpower warranted by any danger class.

Development of this danger class - manpower curve, or Table X, as it is known in this region, has been entirely a process of "cut and try" so far. Starting in 1937 as a straight line relation this has been gradually bent into a concave curve, each succeeding bend producing a reduction in manpower, hence a reduction in the cost of fire control. But each successive increase in this curvature has likewise meant an increase in risk or chance-taking. This balancing of reduced cost against increased risk seems to have reached the limits of empirical development. Concentrated research is now warranted.

(4) The Large Log Study to determine differences in heavy fuel moisture content in wet and dry years was continued in 1946. This is the only fire danger research project carried throughout the war. Four sets of logs have been used since exploratory work was commenced in 1935. The 1942 set is now showing signs of decay and a fifth set must be made and calibrated.

This project is intended to help answer the question whether or not a Class 70 fire day, as rated by our present method, is significantly different in wet season from a Class 70 day during a critical season. Unfortunately (for research) we have not had a critical season since this work was started.

Routine work in this project, and in the 6-month operation of the Priest River fire danger station, the year-long daily weather measurements, the Benton Creek Streamflow project, the snow courses, and general maintenance and operation at Priest River, was done by station superintendent A. W. Peiffer. He had the help of one temporary assistant, a girl forestry student, during the summer months. Over-all supervision was provided by the chief of the Division of Fire Research, H. T. Gisborne, who also served for 6 months as Acting Director of the station during the late Melvin Bradner's illness.

(5) Use of the Priest River Experimental Forest facilities, silvicultural plots, fire research equipment, and other demonstrations began to pick up in 1946 following a four-year period of quietude. Dean McDonald of Iowa State College brought four members of his faculty and about 100 students to this area for a two-month summer school. Lectures were given by LeBarron, Wellner, Friedrich, Barrows, and Gisborne of our Divisions of Silviculture, Range, and Fire. Members of the Kaniksu Forest staff described timber sales and other business, and trained the students and faculty in modern fire suppression methods. This reserve manpower was used several times to great advantage during the peak of the fire season. This school is planning to return in 1947, again using our once-abandoned CCC camp.

The General Integrating Inspection party of some 15 members of the Forest Service used our headquarters lodge, cottages, and cookhouse for a several-day meeting. Some phases of silvicultural research and all fire control studies are readily demonstrated there. The only streamflow study of a true "Little Waters" in this region is also located on this Experimental Forest.

Other visitors of note who found these demonstrations worth several days' study included: Dr. W. C. Lowdermilk and party of five, Dr. and Mrs. Jos. C. Kittredge of the University of California, Dr. and Mrs. Phil E. Church (meteorological consultant on the Hanford, Washington, bomb project), and H. W. Beall of the Canadian Forest Service branch of Fire Research. More use and consultation of this kind is planned for 1947.

A small Ribes-eradication crew was quartered at our cookhouse by the Blister Rust Control organization for about three months. This is the fourth eradication since 1922 for some parts of this Experimental Forest. Considerable rust was found on both plantations and silvicultural reproduction.

B. Plans for 1947

(1) Fire Research is out of balance. Due largely to war-time conditions our fire research of the past several years has become seriously out of balance with both present needs and future

opportunities. From 1942 to 1946 our fire "staff" consisted of one man, the Division Chief, who was also responsible, during part of the period, for general supervision of the silvicultural research work. Funds available for fire research personnel, stenographic assistance, supplies, equipment, and travel amount to only $13,079 for the present fiscal year.

This is obviously far out of balance with the fire menace to our timber resource which alone, at a nominal $1.00 per M bd. ft., is valued at more than $113,000,000. Other destructible values at stake undoubtedly would double this criterion of research justifiable. Our present expenditure is therefore at a rate of considerably less than 1/100 of 1% of the values at stake.

Similarly, Region One expenditures for fire control and slash disposal average around $3,000,000 per year, and this huge program continues with virtually no effort of a research character to insure the effectiveness of those expenditures beyond that which administrators can provide. These men, charged with the action program, have to tie to something. In this region they tie to fire research work done between 1931 and 1936, and terminated in 1937.

Those original principles were derived before the advent of smokejumpers and aerial detection; before the development of much of the heavy equipment now available; and before the construction of hundreds of miles of roads which have greatly changed the accessibility factor on many forests. Former practices also were fitted to an era of "Emergency Programs" with the woods full of trained and organized crews available for both smokechasing and reinforcements.

Today these former reserves of manpower are no longer available, yet extensive timber development and logging activity have accentuated the slash problem and the need for such reserves. New plans are clearly essential. These new plans must also take advantage of the recently constructed roads and thereby decrease our dependence upon former reserves such as the CCC, the WPA, and the more recent military help.

Hence while our old study of fire control planning is still the benchmark which administrators must tie to, both the boundaries and the depths of our sea of knowledge have changed. The old plans and planning methods must be changed and are being changed. Administrators must make these changes on the basis of judgments, estimates, and even guesses, without benefit of research analysis. The job of furnishing new and up-to-the-minute guide lines is clearly of critical importance in Region One.

From still another viewpoint fire research is seriously out of balance. This is evident in the present allocation of station funds to the several lines of research:

Economics - -	31%
Silviculture-	26%
Range - - - -	23%
Utilization -	12%
Fire- - - - -	8%
Total	100%

Funds come to the station earmarked, to a large extent. Hence restoration of balance between fire research effort and the destructible values at stake depends on the provision of funds specifically for fire research.

(2) Piece-meal attack in 1947. Because of the present financial situation both plans and work in 1947 must be opportunistic, doing the best we can with what we've got in meeting current demands, rather than devoted to the long-time problem.

(3) Fire Control Planning is the Number One Job. Although there are three phases of Fire Control Planning or Fire Operations research recognized as needing attention, only two can be touched in 1947. These are (1) thorough analysis of past fire records, (2) a re-examination of the bases, the mapping practices, and the uses of fuel type classification. Nothing can be done on Fuel Reduction principles or practices by the present two-man staff.

The analysis of fire records from 1931 to date, comprising some 25,000 reports, will be pushed by Barrows in proportion to the amount of clerical assistance available. The National Forest fire reports are being machine sorted and tabulated in accordance with the Working Plan for this analysis. Requests will be sent to the Park Service and Office of Indian Affairs, and to the two State Foresters for summaries of their data. Punch-carding of all of these "other agency" data will be necessary in the future, however, if this research is to analyse the regional as well as the local aspects of the fire problem.

Two foreseeable emergencies will interrupt Barrows in this analysis. First will be the 1947 fire season and the need of and opportunity for him to participate in actual fire control, working with and for the regional office. Second is the Aerial Bombing Project, cooperating with the Army and our Washington office. The latter is expected to take from two to three months of Barrows' time between May 1 and mid-September.

The second-to-top priority phase of Fire Control Planning research is Fuel Type investigation. There is urgent need here to re-examine and revise both the old standards of fuel type classification and the field procedures for mapping and using these classifications. The research planned for 1947 will include, first, a re-examination of the basic premises and purposes of fuel type classification, and second, a compilation of the considerable volume of data now available, particularly on rate of spread in each fuel type according to class of fire day. The entire scheme of manning according to measured danger depends upon the dependability of this knowledge.

This analysis will be made on the hypothesis that both present fuel type classification and present fire danger measurements may be wrong. It will also be made with anticipation that danger ratings for specific fuel types may be required to meet the refined uses now possible. This compilation and analysis will be made by Gisborne who is experienced in both fields.

(4) Other phases of Fire Control Planning must wait upon funds. With no assistance in sight it will be impossible this year to make any field studies of rate of hold-line construction. Available information will be assembled, however, on rates of construction by various hand and machine methods. Some of this is obtainable from the fire reports but the sampling method seems likely to be more productive. With such data it will then be possible to re-examine the former assumption or premise that "resistance to control" should be rated, mapped, and used on the basis of hand labor alone. It seems reasonable to expect that this single basis is no longer valid and that under designated conditions a fuel type that is High-High by present standards will become High-Low because of the availability of a bulldozer. Whether this is "sound science" and in accordance with principles of classification for such a purpose remains to be seen.

(5) Fuel reduction studies will be impossible this year except as done by National Forest personnel. There should be some controlled burns made for which it will be possible to determine costs. This is the feature on which data are most urgently needed to check on the varied opinions now held.

(6) Fire Danger Rating system to be reviewed. Two marked groups of opinion concerning the accuracy of Model 6 danger meter ratings have developed during the past two years. One is expressed in the 1946 Integrated Inspection Report to the effect that ratings for August are generally too high. The other group cites three or four troublesome fires which burned much faster than the Burning Index meter indicated.

The problem is threefold. Part of it undoubtedly stems from our fuel type classification standards and methods of application - such as not mapping any type of less than 10 acres in extent. Part of it probably is due to the factors now used in measuring Burning Index, i.e., lack of measurements of fuel moisture in any fuels except branchwood, and in any sizes of dead wood larger than one-half inch diameter. A third factor is our present insufficiency and poor location of danger stations. Few forests have more than one danger measurement station per 100,000 acres, and some of these are at spots not representative of much adjacent topography or fuel types. Many areas of more than 100,000 acres do not have a single danger measurement station.

Present practices in fire dispatching and present flexibility in manning both detection and guard stations now permit use of more refined danger measurements. The research needed is (1) to determine how to improve our present fuel type classifications, (2) what new factors to include in danger measurement, and (3) where the measurements must be made if our "sampling" is to be made more dependable.

(7) Large Log Study will be continued. Part of this research has been underway for several years. This is the Large Log study in which exploratory work was commenced in 1935, for which Hayes wrote a report as his Master's Thesis in 1940, and which is the one fire research project continued according to its original Working Plan throughout the war. In this study the moisture contents of logs 6", 12", and 18" in diameter have been measured at 10-day intervals, May 1 to October 31. Four sets of 3 logs of each size are used; two sets being in full sun, one on the ground, the other on supports a foot or more above ground, and two sets, one on the ground and one above ground, under dense timber. Usable results cannot be obtained until the measurements include at least one critical fire season. We have had none such since 1936.

(8) Special attention will be given to war-born scientific developments which may have value and usefulness in the control of forest fires. Among these are: (1) assembly of information on "pattern forecasting" as developed by the military meteorological services during the war (this is understood to be similar in principle but much more refined than Table 2 in Gisborne's bulletin "Measuring Fire Weather and Forest Inflammability," Circular No. 398), (2) the possible installation and operation by the Weather Bureau of one radar station in this region (Mt. Spokane?) for the more definite and longer-range prediction of lightning and precipitation, (3) other new scientific developments such as Schaefer's (General Electric) use of dry ice to precipitate the moisture in clouds, McEachron's work in lightning protection at Pittsfield, etc., (4) a determination of the statistical probability of occurrence of critical fire seasons in this region.

DIVISION OF RANGE RESEARCH

Management of Short-Grass (Mixed Prairie) Ranges

A. Accomplishments in 1946

(1) Fourteen years of field work at Miles City on the management of native short-grass cattle ranges was concluded in 1946. From 1932 through 1945 two groups of six pastures each were grazed by cattle at three rates of stocking. Livestock used in the grazing trial were disposed of in the fall of 1945. The effects of light, moderate, and heavy stocking on the animals and on the vegetation have been recorded and will be presented in several publications.

Field work during the 1946 season was concentrated on evaluation of the condition of vegetation and soils on the experimental range pastures which had been stocked at the different rates for thirteen years. For this purpose, a series of small areas in the summer pastures were studied intensively. These areas consisted of portions of distinctive and uniform vegetation subtypes that extended across fence lines dividing pastures grazed at different intensities. Thus direct, across-the-fence comparisons between stocking rates in the same vegetation subtype were possible.

(2) Small changes in density of range vegetation resulted from heavy stocking. The average total density of all vegetation on comparable study areas was approximately the same. Only small differences in total density under heavy, moderate, and light stocking were observed. This indicates that no breakdown of total vegetation density occurred on this short-grass range as the result of thirteen years of stocking at the heavy rate. However, small but important differences in composition of the vegetative cover were revealed by comparison of heavily stocked and lightly stocked test areas. These comparisons showed that heavy stocking did result in some deteriorating changes in the composition of the cover. The principal changes were an increase in the percentage of shorter grasses, principally buffalo grass, and an increase in the percentage of grasses of lower forage value such as tumblegrass. The net result of these changes, in combination with other influences of heavy stocking, was to lower both quantity and quality of forage produced on the heavily stocked pastures.

(3) Principal grasses made less height growth on heavily stocked ranges. All principal grasses on heavily stocked summer and winter pastures matured at consistently shorter heights in 1946 than on pastures stocked at the more conservative rates, Table 1. On moderately and lightly stocked pastures these important grasses grew to approximately equal height. Small

differences occurred but were not consistently in favor of either moderate or light stocking. The shorter stature of the important forage species on heavily stocked compared to the more conservatively stocked ranges apparently existed throughout the entire season. Differences in height of plants on test areas on heavily and conservatively stocked summer pastures were found as early as plants became measurable, and the differences increased as growth progressed.

Table 1. Average mature height[1] of principal grasses on pastures stocked at heavy, moderate, and light rates for 13 years, 1932-1945

Intensity of Past Grazing	Height in centimeters							
	Summer Pastures					Winter Pastures		
	As.[2]	Bg.	Sc.	Sv.	Bd.	As.	Bg.	Sc.
Heavy	13.1	4.3	9.7	18.3	4.1	16.6	7.0	12.3
Moderate	16.8	5.9	12.9	none	5.2	17.8	7.9	14.0
Light	16.0	6.4	12.5	21.9	5.7	18.0	8.5	14.6

1/ Fruiting stalks excluded.

2/ As. - bluestem wheatgrass; Bg. - blue grama; Sc. - needleandthread grass; Sv. - green needlegrass; Bd. - buffalo grama.

An additional inch or two of height growth on principal forage species is of considerable importance to the production of beef on the northern short-grass plains ranges. Season-long penalty in height of forage on heavily stocked ranges means lighter yields of forage in terms of either green or dry material. Production tests on the experimental pastures this past season showed that even slight differences in height translate into considerable losses in weight of material available to grazing animals. Reduced production on heavily stocked ranges is particularly serious early in the season when green grass is critically needed.

(4) Less forage was produced by heavily stocked ranges. Heavily stocked summer pastures produced considerably less total forage per acre than moderately or lightly stocked ranges, and forage was of poorer quality, Table 2. Yield and quality of forage from moderately and lightly stocked pastures were approximately equal.

Table 2. Average production of forage by selected areas on summer pastures stocked at heavy and light rates for 13 years, 1932-1945.

Intensity of past stocking	Pounds per Acre - Air-Dry Forage									
	Principal perennial grasses					Other per. grasses	Browse	Perennial forbs	Annual forbs	Total All species
	As.1/	Sc.-Sv.	Bg.	Bd.	Total					
Heavy	252	35	27	47	361	56.9	18.6	4.3	2.3	443
Light	419	59	33	16	526	28.3	14.5	5.7	2.7	577

1/ As. - bluestem wheatgrass; Bg. - blue grama; Sc. - needleandthread grass; Sv. - green needlegrass; Bd. - buffalo grama.

Yields of most of the important grasses on this type range, particularly bluestem wheatgrass, were less under heavy stocking. More buffalo grass, on the other hand, was produced by heavily stocked than by more conservatively stocked pastures, but the heavily stocked pastures still showed a 31 percent deficit in total production of principal grasses. Production of secondary perennial grasses of little grazing value (mostly tumblegrass, Schedonnardus paniculatus) was also greater for heavily stocked than for conservatively stocked pastures. Reduced production of the principal forage grasses through heavy stocking is serious. These species are among the most palatable to cattle, and make up the bulk of range cattle forage.

Browse (mostly fringed sage) and annual and perennial forbs made up only a very small percentage of the total vegetative cover of all pastures in 1946, and yields were about equal under the 3 rates of stocking. Apparently the heavy rate of stocking was not severe enough to open the range to serious invasion of weed species.

(5) Soil and moisture conditions were adversely affected by heavy stocking. Soils on heavily stocked areas were more compact and had less pore space than comparable soils on lightly and moderately stocked areas. This was shown by volume-weight samples of the surface 2 inches of soil. Samples from heavily stocked areas averaged from 4 to 10 percent heavier than volume-weight samples from lightly and moderately stocked areas on the same soil types. These differences in weight mean a reduction of from 5 to 8 percent in pore space on the heavily stocked areas. Greater compactness and decreased pore space in the soils under heavy stocking influence the ease and rapidity with which water enters the soil.

Plant litter remaining on the soil surface on heavily stocked areas was only 1/3 to 1/2 as great as the amounts of litter remaining under moderate and light stocking. This litter has considerable influence in maintaining the soil in a condition favorable to the rapid intake of water. Greater compactness of the soil and less surface litter under heavy stocking help to explain the observed differences in rainfall penetration and rate of water intake on the soils in the areas stocked at the different rates.

Rainfall penetration was significantly less on heavily stocked portions of the same soil and vegetation subtypes than on the lightly or moderately stocked portions. Significant differences in rainfall penetration between heavily stocked areas and lightly stocked areas were detectable following rains of as little as 0.37 inches. Decreased penetration of rainfall on heavily stocked ranges logically means less moisture in the soil for the production of forage.

Intake of artificially applied water was much slower on heavily stocked areas than on lightly or moderately stocked areas. Heavily stocked soils required from two to four times longer for the absorption of a measured amount of water than did lightly or moderately stocked soils. With reduced rate of water intake greater runoff losses are to be expected, and as a consequence less soil moisture will be available for the growth of forage plants.

(6) Management studies on crested wheatgrass pasture were continued. The heavily stocked crested wheatgrass pasture at the range station was grazed for the eighth season in 1946. Twenty-one yearling steers were placed on the 46½-acre pasture on April 3. For the 71-day period from May 1 to July 10 steers averaged 2.31 pounds gain per day, a very satisfactory rate. During the whole period of use the crested wheatgrass pasture provided a total of 146 days' grazing for the 21 steers with an average daily gain of 1.37 pounds.

Renovation treatments started in 1945 on the crested wheatgrass pasture have not yet produced any significant increases in forage yield. Treatments consisted of harrowing and disking to reduce density of the stand followed by protection from grazing.

(7) Management studies were explained at field days. Two field days at Miles City during the 1946 season provided opportunity for explaining the studies of the Forest Service on the management of short-grass ranges. The Montana State College Advisory Council met at the station on June 27 and 28. Seventeen of the Council members were present, including several ranch operators, and, with others attending, the group totaled over 30. On September 4 and 5, a field demonstration was held for

23 forest officers from Region One. Field examinations of pasture condition after 13 years (1932-1945) of heavy, moderate, and light stocking were made by the entire group. Questions and discussions were of value to both visiting forest officers and station research personnel.

B. Plans for 1947

Work will be concentrated on manuscript preparation. All efforts will be concentrated on the analysis of accumulated data and the preparation of manuscripts. At Miles City practically full time will be devoted to the task of analyzing and writing up the effects of three stocking rates on vegetation and soil. Some of the late data on response of cows and calves to rate of stocking also remains to be written up for final publication. A manuscript for state publication on the influence of heavy stocking on calf crops and development of calves to long yearlings is now in preparation. The preparation of a manuscript on the analysis of range problems of the Northern Great Plains is well under way. Field work will be confined to the maintenance of important records on the crested wheatgrass pasture and the experimental native range pastures, if the latter are grazed.

Management of Summer Ranges

A. Accomplishments in 1946

(1) Research on summer ranges was resumed in 1946. Since the return of Grant Harris from the Navy last May his time has been devoted primarily to analyses of data collected at the Vigilante experimental range prior to 1944. Field trips were made by him late last summer for generalized observations and records needed to round out a manuscript planned for departmental publication. Some conclusions reached or reaffirmed are listed below.

(2) More forage can be safely utilized on the Vigilante range if intensified management practices are adopted. This conclusion is based on an accumulation of utilization data covering the period 1938 to 1943.

The average use of Festuca idahoensis and Agropyron spicatum was only 16 and 12 percent, respectively, measured to the ground level, as determined by detailed utilization surveys conducted each of the six years. These two key species are the most important forage plants on the range and are used as indicators of grazing pressure. Heaviest use occurred near water, shade, etc., with lighter use on steep slopes and remote areas.

A tentative use standard has been set up which is expressed in terms of the percent of these two species remaining at the close of the grazing season. A basic reserve of approximately 60 percent of Festuca idahoensis and 65 percent of Agropyron spicatum, when measured to the ground level, is needed to maintain this range in good condition on relatively level mountain cattle range of this general type. Further data are necessary to determine just how much additional reserve is needed for different soils and steeper slopes in order to safeguard watershed and soil resources. However, from observations of quadrats and plant development studies which show an uptrend in vigor and condition in recent years, it seems evident that some of the differences between 16 and 12 percent average use and 40 and 35 percent allowable use on relatively level range might be safely utilized under more intensive management.

If the average utilization could be increased safely, even to 25 and 20 percent respectively for these two key species, livestock numbers could be substantially increased and the community benefited correspondingly. Good distribution by better herding, salting, water facilities, and more intensive management generally will be needed before the full possibilities of heavier use may be safely realized.

(3) Grazing on the Vigilante range may be safely started by about May 20 on the average, as determined by plant development records and other data covering the period from 1938 to 1944. This confirms a tentative conclusion previously reached. The present opening date of June 1 is thus conservative.

Range readiness is indicated by the occurrence of the 3- to 3½-inch leaf height stage in Festuca idahoensis and Agropyron spicatum. These two species have made approximately 80 and 60 percent, respectively, of their maximum leaf height growth at this time, and are tall enough to be easily available forage for cattle. Trend in vigor has been upward, as shown by increased density and height growth under the present plan of opening the range for grazing use on June 1. Also intensive close clipping studies of these grasses beginning on the average at May 20 caused no more decline in forage production than clipping three weeks later.

Moreover, rainfall has averaged 25 percent greater in the June 1-10 period than in the May 21-31 period. This indicates that more damage may be done by trailing the cattle onto the range in early June.

B. Plans for 1947.

Completion of a manuscript for publication as a USDA circular on plant development in relation to management practices is of top priority. Considerable time has already been spent on this job; the analysis is well along, and some work has been done on an outline.

Artificial Range Reseeding

A. Accomplishments in 1946

(1) Range reseeding investigations during the past year have been concerned mainly with detailed studies of established plantings rather than with the making of new plantings. Studies of yield, seasonal development of species, effects of site factors such as competition by native species, effect of competition upon life span of the various species seeded in mixtures, etc., have been started. Because of the long-time nature of some of these studies there is not much in the nature of concrete results to report at this time, but some tentative interpretations warrant brief mention here. Only 7 new planting studies were put out in 1946.

(2) Species adaptation tests showed good results at several areas. Smooth brome is showing remarkable ability to grow and reproduce on raw shaly soils at the 8600-foot high Round Hill erosion area on the Vigilante sheep range. Crested wheatgrass and tall oatgrass are also growing well and producing seed but are unable to extend their range from the relatively favorable terrace trenches onto the raw slopes as readily as does the smooth brome by means of its rhizomes. Numerous thrifty plants of Ladak alfalfa and yellow sweet clover have survived from the 1944 spring plantings. Growth of these soil building plants on such areas may hasten rehabilitation.

Fifteen of the 40 species and strains seeded at the 9350-foot high altitude nursery at Vigilante in 1942 were rated as "very good" to "excellent." Only meadow foxtail made seed in 1946 although many species produced heads which were killed before filling by a heavy freeze in August. The outstanding species and strains are: Fairway crested wheatgrass, thickspike wheatgrass, slender wheatgrass, violet wheatgrass, bearded wheatgrass, meadow foxtail, meadow brome (B. erectus), smooth brome, Parkland brome, Siberian wild rye, Virginia wild rye, sheep fescue, red fescue, timothy, and Kentucky bluegrass. Many dead plants of standard crested wheatgrass were found.

Bluegrass hybrids and strains are being tested to find productive strains for dry land. From 1 to 25 plants of each of 16 out of 23 Poa pratensis x P. arachnifera hybrids and 2 to 40 plants of each of 7 out of 9 selections of P. pratensis obtained from the BPIS & AE and planted in the spring of 1946 survived the summer at the Antrim experimental range reseeding area in the Bitterroot Valley.

(3) Studies of competition and other site factors yielded helpful information. Seeding of grass on burned-over timberland in western Montana has been much more successful on areas that had been densely timbered than where the timber was more widely

spaced. Competition from fire-tolerant native grasses and shrubs is doubtless the main factor preventing success in open stands. Forage yields in 1946 on the seeded portions of the 1944 Henry Creek burn, Cabinet N.F., varied from 1,040 pounds per acre (about 60 percent native pinegrass) on typical openings, to 2,075 pounds per acre (almost pure reseeded species) on typical sites under dense stands of fire-killed trees. These yields, determined by the weight estimate method, represent air-dry weight of forage above a 1-inch stubble.

Several forage grasses are making good headway in revegetating skid roads, and promise to control the return of low value species such as pinegrass. Quadrats established in 1944 on skid roads, which were seeded in the fall of 1943 and the spring of 1944 on the Hart Creek sale area of the Bitterroot National Forest, were remeasured in 1946. They show that the reseeded plants have more than tripled their 1944 basal areas while pinegrass has been reduced to 1/4 of its previous hold on the quadrats. Orchard grass, Kentucky bluegrass, and timothy accounted for practically all the gain, while crested wheatgrass barely held its own. These results were obtained in spite of heavy grazing each season since planting.

Other detailed studies of competition were begun in 1946 at two locations. In order to record behavior of species seeded in mixtures a series of permanent chart quadrats were established on mixture plots at the Antrim area. Seven permanent brush plots were mapped and photographed to provide a base for recording effect of brush competition on reseeded forage species at the Henry Creek seeding area.

(4) New methods of planting studies were started. Feasibility of preparing cheatgrass land for reseeding by burning was tested on 7 dates at the Antrim area. Records were kept on wind movement, humidity, temperature, weather conditions, rate of spread, stage of development of cheatgrass, and completeness of burn. Cheatgrass seedlings were counted in the fall. Soil of unburned plots was prepared by various methods and all plots were seeded to crested wheatgrass in October.

Spring and fall plantings were made to test effect of depth of seeding and firmness of seedbed upon 6 of the outstanding species at the Antrim area.

A study to test effect of row width and rate of seeding upon crested and intermediate wheatgrass, when heavily grazed and ungrazed, was established on well prepared soil at the Antrim area in the fall.

(5) Studies of growth habits and value of species were intensified. Stage of development studies are yielding valuable information concerning growth habits, earliness, summer greeness, time of seed setting, fall regrowth, etc., for the major reseeding

species. The study consisted of periodic field examinations of between 40 and 50 species, mainly in row plots, and of a review of observation data in the files. Most frequent field observations were made at the Antrim area, but enough data were also collected at Judith Basin to make some comparison between growth at the two areas. The one-year records have not been completely compiled and will not be conclusive, but some of the more definite indications are: (1) Big bluegrass has more green vegetation present in very early spring, and ripens seed earlier than any species studied. (2) Big bluegrass, Russian wild rye, and sheep fescue tend to stay green into late summer, but their leaves become very tough after seed ripening. (3) Plants of many species stay green longer into the summer during their first one or two growing seasons than they do as they grow older. (4) Intermediate wheatgrass seems to start growth about the same time in the spring as crested wheatgrass, and stays green somewhat longer into the summer. Both appear to make some green growth during relatively mild periods in the winter.

One- to five-year-old stands of 15 forage species were sampled for yield at the Antrim and Judith Basin areas. Work was largely exploratory, to develop methods and techniques. Data collected are not conclusive because lack of large enough populations to give adequate samples of many of the species age classes precluded getting thoroughly sound data. Only those portions of plots supporting 75 or 100 percent stands were sampled. In this way it should be possible to compare the potential ability of species to yield when adequate stands are obtained. Future efforts may then be directed to develop better methods of planting the most productive species.

In an effort to provide adequate populations for future sampling 10 of the most promising species were planted in 1/40-acre plots at the Antrim area and 16 were planted in 1/30-acre plots at Judith Basin. The adequate seeding rates used on well prepared seedbeds resulted in good stands on nearly all of these plots.

(6) Aid given in planning reseeding work on national forest ranges. Friedrich, with C. W. Jackson of Range Management, spent about 3 weeks in August and September making field examinations and preparing specific recommendations for treatment of numerous proposed reseeding areas on 7 national forests. This was a cooperative effort to obtain administrative plantings on the forests to serve as pilot plant or demonstration seedings to guide and encourage further reseeding of sore spots on forest ranges. Seeding work was done by the forests.

(7) Role of reseeding in progressive land management demonstrated to key men. On June 6, a field day was held on reseeding work in the Bitterroot Valley. The experimental work at the Antrim

area, several of Mr. Antrim's private plantings of crested wheatgrass on preparatory crop stubble and otherwise, some outstanding seedings on the Ed O'Hare ranch, and the skid trail seedings at Reimel Creek, were visited and discussed. Real interest was shown by Forest Service administrative men who attended.

B. Plans for 1947

(1) Analysis of accumulated reseeding data and preparation of a manuscript for a USDA circular will be the major undertaking in 1947. This is to be a progress report on species and methods of planting adapted to central Montana. An outline has already been sent to the Washington Office for review.

A processed station paper or guide to reseeding practices already well along is to be completed early this season. If time will permit, one or two brief farm journal articles may also be written from available information.

To encourage use of results now available field days with local ranchers and land managers will be held as the opportunity presents, especially in the Bitterroot Valley.

(2) Little or no new planting is planned for 1947. However, records for those already installed will require more time than one man now on the job can handle, considering the writing schedule mentioned above.

DIVISION OF FOREST WILDLIFE INVESTIGATIONS

A. Accomplishments in 1946

(1) **Wildlife investigations were resumed after lapse of three years.** Wildlife investigations were restored to an active status when a biologist was assigned to the Station by the U. S. Fish and Wildlife Service on July 1, 1946. The project was suspended in 1943 when the former Station biologist entered the Army.

Orientation occupied the first six weeks. During this period, the forest biology problems of the region were considered and literature was reviewed as a basis for planning work. Four major problems of forest management in which wildlife plays an important part were presented to the biologist when he first came to the station:

(a) Deer browsing injury to ponderosa pine reproduction.

(b) Birds and rodents in relation to destruction of conifer seed, both natural seed fall and artificial seeding (direct seeding).

(c) Porcupine damage to conifers.

(d) Damage by snowshoe hares and other wildlife to forest plantations.

(2) **Deer browsing damage to ponderosa pine was chosen for study.** Deer browsing injury to ponderosa pine reproduction was selected for the first major line of work because it was reported that such injury probably is seriously retarding the regeneration of this important tree. Field work was begun on the Fisher River in the Kootenai National Forest after inspecting several possible sites. The Fisher River drainage has a comparatively high population of both white-tailed deer and mule deer, and an abundance of mature ponderosa pine timber with inadequate natural reproduction. Local forest officers believe that deer are at least partly the cause of the sparse reproduction of pine. During June, 1946, National Forest and Experiment Station personnel had set up some small deer exclosures in Wolf Creek and Cow Creek, branches of Fisher River. Fence for the deer exclosures had been provided by the Montana Fish and Game Commission. Hence the area appeared well suited for the proposed study.

Deer populations and distribution, food habits, reproduction, predation, and hunting pressure were studied during the remainder of the year. This work is preliminary to an objective quantitative analysis of the use of pine which will be made after the end of the winter season.

Information was gathered during the hunting season on hunting pressure, deer kills, weights, and parasitization, as a by-product to the main line of work. It will be published in a Station Research Note and in one or two magazine articles.

B. Plans for 1947

(1) Complete Fisher River deer-pine problem. An appraisal of the extent and significance of browsing on pine will be made in the early spring period with the help of personnel from the Station's Division of Silviculture and National Forest personnel. This will terminate the field work on the study. The data will be analyzed and reported the following winter.

(2) Investigate effect of DDT on Wildlife. Studies of the effect of DDT on vertebrate wildlife probably will be undertaken in the vicinity of Moscow, Idaho, in May and June. The Bureau of Entomology and Plant Quarantine and the Forest Service are planning to spray 350,000 acres of forest land for the control of a tussock moth epidemic. Congressional action is required before the spraying can be performed. Therefore, the plans are not wholly certain. If the project is carried through, the results will be analyzed after the end of the field season.

(3) Initiate clipping studies on ponderosa pine. Experimental clipping of young ponderosa pine to simulate deer browsing will be initiated in July or August. Follow-up examinations of these experiments will extend over several years.

(4) Resume pre-war studies of rabbit damage to plantations. There are several planting experiments in Idaho which were designed to measure rabbit damage as well as other factors of planting on brushy sites. These plots will be reexamined during August and September.

DIRECT AND INDIRECT COSTS BY FINANCIAL PROJECTS

F. Y. 1947

Financial Project	Indirect Project Costs (Overhead)	Direct Project Costs	Total Costs
Forest & Range Management	$ 11,700	$ 86,256	$ 97,956
Forest Products	2,550	18,776	21,326
Forest Resources Investigations	5,750	42,250	48,000
Total	$ 20,000	$147,282	$167,282
RPS		6,650	6,650
1946 Lumber Census		2,850	2,850
Grand Total	$ 20,000	$156,782	$176,782

DISTRIBUTION OF DIRECT COSTS BY MAIN PROJECTS

F. Y. 1947

Financial and work project	Cars, maintenance & new	Scientific equipment, etc.	Travel expenses other than cars	Salaries Regular	Salaries Temp.	Total
FOREST & RANGE MANAGEMENT INVES.						
501	$ 4,000	$1,973	$ 3,000	$ 27,506	$2,251	$ 38,730
503				2,640		2,640
510		130		2,986	1,191	4,307
520			121	10,124	334	10,579
540	200	1,000	1,200	26,649	951	30,000
Total	4,200	3,103	4,321	69,905	4,727	86,256
FOREST PRODUCTS						
575	100	98	1,000	7,915		9,113
580	100	231	850	4,078		5,259
585		269	250	2,209		2,728
590			261	1,415		1,676
Total	200	598	2,361	15,617		18,776
FOREST RESOURCES INVESTIGATIONS						
601	4,000	2,000	4,035	10,167	2,248	22,450
602	4,000	1,000	2,345	11,944	511	19,800
Total	8,000	3,000	6,380	22,111	2,759	42,250
RPS	200	100	425	5,925		6,650
1946 Lumber Census		200	400	2,250		2,850
Grand Total	$12,600	$7,001	$13,887	$115,808	$7,486	$156,782

PUBLICATIONS

1. ISSUED DURING 1946

Anderson, I. V.
Forest utilization possibilities of the northern Rocky Mountain area. March 12, 1946. Mimeog. 6 pp.

_____
How can we improve round timbers? April 1, 1946. Mimeog. 5 pp.

_____
Laminated wood and what it means to Montana. May 25, 1946. Mimeog. 11 pp.

Brown, C. W. and Kemp, P. D.
Annual and periodic growth tables for north Idaho species. January 7, 1946. Mimeog. 9 pp.

Forest Utilization Service
Review of cross tie specifications. May 1946. Mimeog. 2 pp.

_____ (in cooperation with R-1 Division of Timber Management)
Cost of manufacturing lumber, exclusive of interest, discount and income tax, for Inland Empire sawmills during 1945. Confidential. June 20, 1946. Multi. 1 p.

_____
Partial list of manufacturers of equipment for the post and pole industry. December 1946. Mimeog. 1 p.

Helmers, Austin E.
How heavily should western white pine be pruned? Research Note 41. April 1946. Mimeog. 4 pp.

_____
Fifth-year results of direct seeding with western redcedar and Engelmann spruce. Research Note 42. April 1946. Mimeog. 4 pp.

_____
Direct seeding western white pine - - fifth-year results. Research Note 44. June 1946. Mimeog. 5 pp.

_____
Effect of pruning on growth of western white pine. Jour. For. 44(9):673-676. September 1946.

_____
Pruning wound healing on western white and ponderosa pines. Research Note 45. December 1946. Mimeog. 6 pp.

_____
Results of direct seeding ponderosa pine. Research Note 46. December 1946. Mimeog. 5 pp.

Hurtt, Leon C.
Penalties of heavy range use. American Hereford Journal. July 1, 1946.

Kemp, P. D.
Publication procedure for maps. April 29, 1946. Mimeog. 3 pp.

_____
Special techniques for maintenance surveys. May 2, 1946. Mimeog. 5 pp.

LeBarron, Russell K.
The second-growth situation in Idaho and Montana. Western For. and Cons. Assoc. Proc. of 36th Annual Meeting pp. 11-12. December 1945 (Published 1946).

Mueller, Lincoln A.
Utilization of the secondary species in the Inland Empire. Jour. of For. vol. 44, no. 11, November 1946.

Timm, John L.
Conversion of standard pole classes to tree diameters in lodgepole pine. March 8, 1946. Research Note 39. Mimeog. 2 pp.

_____
Christmas tree production in western Montana in 1945. May 15, 1946. Research Note 40. Mimeog. 2 pp.

Wellner, C. A.
Improving composition in young western white pine stands. Research Note 43. June 1946. Mimeog. 6 pp.

_____
Recent trends in silvicultural practice on National Forests in the western white pine type. Jour. For. 44(11):942-944. November 1946.

_____
Estimating light intensity in residual stands in advance of cutting. Research Note 47. December 1946. Mimeog.

Whitney, C. N.
Results to date of studies of the durability of native woods treated and untreated. Rev. January 1946. Station Paper 5. Mimeog. 54 pp.

_____
Instructions for preservative treatment of telephone poles, stubs, and fence posts. Rev. May 1946. Mimeog. 10 pp. plus 7 plates.

2. DEPARTMENTAL PUBLICATIONS PLANNED - F. Y. 1947

Hurtt, Leon C.
Cattle range management and drought. 80-100 pages.

Schopmeyer, C. S. and Helmers, Austin E.
Seeding as a means of reforestation in the northern Rocky Mountain region. For U.S.D.A. Technical Bulletin or Circular. Submitted to Washington Office, August 1946, after revision following review by national board of review. 67 pages typewritten, 6 tables, 5 photographs.

Woolfolk, E. J.
Sheep range management. 70-80 pages.

3. DEPARTMENTAL PUBLICATIONS PLANNED - F. Y. 1948

Friedrich, C. A.
Adaptation of species to central Montana ranges. Manuscript of 60-70 typed pages for U.S.D.A. circular.

Harris, G. A.
Plant development on southwest Montana summer ranges in relation to management practices. Manuscript of about 60 typed pages for U.S.D.A. circular.

Holscher, Clark E.
Utilization of short-grass range by cattle. Manuscript 85-90 pp. for U.S.D.A. circular.

Whitman, Peterson, Reed, and Woolfolk.
Effects on short-grass range vegetation, soil and cattle of three stocking rates, a manuscript of approximately 120 typed pages for U.S.D.A circular or bulletin.

4. OTHER PUBLICATIONS PLANNED FOR RELEASE IN 1947

Barrows, J. S.
Progress report on the aerial bombing project. Fire Control Notes.

_____
The total fire load in the Northern Rocky Mountain Region. Station paper or Fire Control Notes.

Division of Forest Economics
1. Statistical report for Benewah County, Idaho.
2. Statistical report for Cascade County, Montana.
3. Statistical report for northeast Washington.

Division of Range Research
Two or more short articles for livestock, farm, or semi-technical journals on reseeding and range management subjects.

Gisborne, H. T.
Fire control operations research. Journal of Forestry.

_____
Duration of fire danger with altitude and aspect. Fire Control Notes.

Helmers, Austin E.
Direct seeding in the Inland Empire. (Paper read at annual meeting of Northwest Scientific Association, December 1946.) For publication in Northwest Science.

Hurtt, Leon C.
Problem analysis of the Northern Great Plains. Station paper.

_____, and Friedrich, C. A.
Range reseeding guide. Station paper.

LeBarron, Russell K.
A forest management research program for western Montana. For publication in Proceedings of the Montana Academy of Sciences. November 1946.

_____
The social implications of forest management research. (Paper read at annual meeting of Northwest Scientific Association, December 1946.) For publication in Northwest Science.

Wellner, C. A.
Light intensity related to stand density in mature stands of the western white pine type. Submitted to Journal of Forestry, December, 1946.

_____
Forest protection in the silviculture of western white pine forests. (Paper read at annual meeting of Northwest Scientific Association, December 1946.) For publication in Northwest Science.

PERSONNEL OF STATION - December 31, 1946

OFFICE OF DIRECTOR

Chas. L. Tebbe	Director
Mary J. Pershina	Administrative Assistant
Elizabeth H. Heisel	Clerk-typist

DIVISION OF FIRE RESEARCH

Harry T. Gisborne (chief)	Silviculturist
Jack S. Barrows	Forester
Helen B. Davis	Clerk-stenographer
Albert W. Peiffer	Agricultural Aide

DIVISION OF SILVICULTURAL RESEARCH

Russell K. LeBarron (chief)	Silviculturist
Charles A. Wellner	Silviculturist
Austin E. Helmers	Silviculturist
Helen B. Davis	Clerk-stenographer

FOREST UTILIZATION SERVICE

Irvin V. Anderson (chief)	Forester
Lincoln A. Mueller	Forester
Marie E. Bouchard	Clerk-stenographer

DIVISION OF RANGE RESEARCH

Leon C. Hurtt (chief)	Range Examiner
C. Allan Friedrich	Forest Ecologist
Warren C. Whitman	Forest Ecologist
Grant A. Harris	Range Examiner
Roald A. Peterson	Range Examiner
Merton J. Reed	Range Examiner
Dorothy P. Truxler	Clerk-stenographer

DIVISION OF FOREST ECONOMICS

M. B. Dickerman (chief)	Forest Economist
S. Blair Hutchison	Forest Economist
Clarence W. Brown	Forester
Lewis L. Folsom	Forester
Paul N. Holmes	Forester
Paul D. Kemp	Forester
Elwyn F. Peffer	Forester
Edward W. Smith	Forester
Henry J. Pissot	Timber Management Assistant
Robert L. Conn	Agricultural Aide
Melvin E. Metcalf	Statistical Clerk
Monica E. Hobe	Clerk-stenographer
Dorothy M. Jones	Clerk-stenographer

WESTERN MONTANA WORK CENTER

Russell K. LeBarron (chief)	Silviculturist
Arthur L. Roe	Silviculturist
C. Allan Friedrich	Forest Ecologist (Range)
Kenneth N. Boe	Forester
Grace E. Dygert	Clerk-stenographer

DIVISION OF FOREST WILDLIFE INVESTIGATIONS (in cooperation with Fish and Wildlife Service)

Lowell Adams	Biologist

IN MILITARY SERVICE

Anthony B. Evanko

FIELD STATIONS

Deception Creek Experimental Forest	Austin E. Helmers
Priest River Experimental Forest	Albert W. Peiffer
Miles City Experimental Range	Warren C. Whitman
Vigilante Experimental Range	Grant A. Harris

STATUS SHEETS - SILVICULTURAL RESEARCH

These status sheets have all been rewritten since last submitted and are enclosed for your information. They supplement the rather brief treatment of this activity in the textual part of this report.

January 1947

HARVEST CUTTINGS - WESTERN WHITE PINE TYPE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Harvest Cuttings (Western White Pine Type)

PURPOSE OF WORK: To develop methods of stand management that will bring about (1) maximum production of desired products and minimum mortality losses, and (2) adequate natural regeneration of desired species.

REVIEW OF PAST WORK: Much of the station's silvicultural research program since its beginning has centered around methods of cutting and natural regeneration. Various studies of cutting methods, seed supply, seed germination, initial survival, establishment, early development, and slash disposal have been made and described from time to time in numerous publications and reports. The results of most of these studies were brought together in comprehensive fashion in "Natural Regeneration in the Western White Pine Type," U.S.D.A. Technical Bulletin No. 767. With the publication of this bulletin, several studies were closed and the way cleared for new investigations.

A study of the economics of managing western white pine forests, begun in 1938 and published as U.S.D.A. Technical Bulletin No. 830, provides an economic evaluation of various silvicultural practices and methods. Recent work has also included studies of stand development during the early and formative years. In cooperation with other agencies, a preliminary study of root diseases in white pine was completed in 1938 and a report of results issued as Station Paper No. 1. A cooperative report with the Spokane Blister Rust Control office was prepared in 1940 on blister rust control in the management of western white pine.

Most recent studies have been concerned mainly with the possibilities of partial cuttings. Studies of light cuttings in immature stands were begun in 1937 in cooperation with F. S. Administration and the former station Division of Forest Products. These have been continued and somewhat expanded. Studies of light cuttings in mature stands to harvest defective and poor-vigor trees were begun as a cooperative study with the Bureau of Entomology and Plant Quarantine in 1939 with trial cuttings in the Deception Creek Experimental Forest and Rapid Lightning Creek on the Kaniksu National Forest.

Knowledge on cutting methods in the white pine type may be summarized as follows:

The clearcutting, seed tree, and shelterwood methods all deserve a place in management. Seed tree and shelterwood cuttings favor reproduction of white pine. After removal of merchantable timber from

decadent old stands it is best to burn the debris and reforest by planting or seeding. Seed tree cuttings must be abandoned in many cases because of the blister rust hazard. Alternatives that favor easier control of blister rust are (1) clear cutting and burning either with one or two burns, or (2) partial cuttings that cause devitalization of ribes seed in the soil and suppression of ribes which germinate. Partial cuttings tend to favor hemlock and grand fir and hence it may be necessary to make cleanings after the old timber has finally been cut. Partial cuttings offer an aid to insect control by maintaining stand vigor. The economic superiority of a partial-cutting over a single-cutting plan of management has been demonstrated through an economic analysis. A rotation of 120 to 140 years is indicated as most desirable both from the standpoint of volume and value.

ACCOMPLISHMENTS DURING PAST YEAR: (1) Marking rules were prepared for submission to F. S. Administration as a substitute for the 1932 marking rules in the R-1 timber management handbook. (2) Studies of partial cuttings in immature and mature stands were continued as follows: (a) An office report summarizing mortality on four sets of partial cutting plots was prepared and sent to interested agencies. (b) Fifth-year mortality and growth were measured on 7 plots in mature stands. (c) Twenty-first-year growth was measured on one plot in a young stand. (d) Over fifty 1/5-acre permanent plots were established in advance of partial cutting a mature stand in an administrative sale on Steamboat Creek, Coeur d'Alene National Forest. (3) A three-day meeting of timber management staff assistants was held on the Deception Creek Experimental Forest to discuss and see white pine management practices. (4) Four papers were prepared on white pine cutting practices: (a) "Recent Trends in Silvicultural Practice on National Forests in the Western White Pine Type," Journ. For. 44, 942-944. (b) "Forest Protection in the Silviculture of Western White Pine Forests," for Northwest Scientific Association meeting. (c) "Estimating Light Intensity in Residual Stands in Advance of Cutting," Station Research Note 47. (d) "Light Intensity Related to Stand Density in Mature Stands of the Western White Pine Type," for Jour. For.

PLANS FOR 1947: (1) Studies of partial cutting to be continued as follows: (a) Prepare reports on mortality and growth on three tests of partial cuttings in mature stands and one test in an immature stand. (b) Remeasure partial cutting plots on Steamboat Creek. (c) Remeasure 17 plots testing partial cuttings in immature stands. (d) Remeasure 2 plots testing partial cuttings in mature stands. (e) Establish one new test in a mature stand. Establish one new test in an immature stand. (f) Develop tree and stand vigor classifications in cooperation with Forest Insects Laboratory. (g) Furnish advice and assistance for special study of white pine blister rust control. (2) Hold meeting at Deception Creek on white pine management for forestry schools, state and private agencies.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: Wellner, Helmers. (Cooperators, J. C. Evenden, Forest Insect Laboratory and V. D. Moss, Office of Blister Rust Control.)

January 1947

STAND STUDIES - WESTERN WHITE PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Mensuration

LINE PROJECT: Stand Studies (Western White Pine Type)

PURPOSE OF WORK: To determine composition, growth, mortality, and yield in western white pine stands.

REVIEW OF PAST WORK: A type-wide study of growth and yield in fully stocked natural stands was published as U.S.D.A. Technical Bulletin 323.

Some 34 permanent and 41 semi-permanent growth plots have been established and are periodically remeasured.

Increment and mortality have been measured on 24 permanent plots in cut-over, mature, and overmature stands. Ten-year records for nine of these plots showed a consistent loss of the residual stand in net volume amounting to 20 percent the first decade, substantiating the observation that old white pine stands have a tendency to deteriorate following a heavy partial cutting.

A type-wide study of increment and mortality has been made in cut-over stands using temporary plot technique. Field work was done in 1928, 1937, and completed in 1938. Compilation of data has been completed.

ACCOMPLISHMENTS DURING PAST YEAR: Remeasured 7 semi-permanent yield plots.

PLANS FOR 1947: A large volume of worthwhile data are on hand from remeasurements of the permanent and semi-permanent plots and also from the type-wide study in cut-over stands. These should be analyzed and reported, but the records are voluminous and much work will be required. The job must wait until more time and computing assistance become available.

Plans for 1947 include: (1) Preparation of an emperical yield table for use in the study of Blister Rust Control. (2) Remeasurement of 29 semi-permanent and 9 permanent yield plots. (3) Establishment of 10 one-tenth acre semi-permanent growth plots in older white pine plantations.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: LeBarron, Wellner, Helmers.

January 1947

STAND IMPROVEMENT - WESTERN WHITE PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Stand Improvement (Western White Pine Type)

PURPOSE OF WORK: To develop stand improvement methods which will improve the quality and growth of immature stands.

REVIEW OF PAST WORK: Studies of intermediate cuttings were begun in 1914 with the establishment of a series of thinning plots. Work was continued in a more or less desultory fashion until 1933 when, with establishment of the Deception Creek Experimental Forest and availability of emergency funds, a moderate program of stand improvement was undertaken. Fairly extensive work was also performed by the administrative organization. In 1936 available information on stand improvement practices was assembled in a mimeographed manual, "Stand Improvement Practice in the Western White Pine Type," and accepted by Administration as standard instructions for this class of work.

In 1938, in cooperation with Region One, a rather comprehensive summary was prepared of stand improvement work done in both western white pine and ponderosa pine. All information available, plus additional silvicultural data obtained in the field, was systematically assembled in unit reports and a brief summary of results was prepared.

Periodic remeasurements are made on the following permanent plots: thinnings and improvement cuttings 42, weedings 18, pruning 12, girdling 2.

Results to date indicate that thinnings and improvement cuttings in pole stands should be applied with caution. Although such cuttings usually result in accelerated growth on selected trees, this gain may be outweighed by damage from snow and sunscald. Benefits are usually offset also by treatment costs. Improved markets for poles, pulpwood, and fuelwood will improve the outlook for these cuttings. Stand improvement measures offering the most promise at the present time are cleanings or weedings to release desired species, and pruning of yound white pine.

ACCOMPLISHMENTS DURING PAST YEAR: 1. Measurements of pruning plots compiled and reported on in two research notes and one Journal of Forestry article as follows: (a) "How Heavily Should Western White Pine be Pruned?" Station Research Note No. 41. (b) "Pruning Wound Healing on Western White and Ponderosa Pines," Research Note No. 45. (c) "Effect

of Pruning on Growth of Western White Pine" Jour. For. 44:673-676. Major results reported are as follows: Only about one-third of the live crown of white pine can be removed without substantially lowering the rates of growth, both in diameter and height. Optimum conditions for rapid wound healing result from close pruning small live branches on rapidly growing trees. 2. Measurements of four weeding plots were compiled and reported on in Station Research Note No. 43, "Improving Composition in Young Western White Pine Stands." The major conclusion reported was that cleanings, to be effective, should be delayed until dominance is well established, at which time the cleaning operation should be heavy. 3. Start made on up-to-date R-1 stand improvement guide. 4. Remeasured 13 weeding and 2 girdling plots.

PLANS FOR 1947:

1. Complete guide for R-1 stand improvement practices.
2. Compile data and prepare reports on (a) 13 weeding plots, and (b) 2 girdling plots, mentioned under 4 above.
3. Remeasure 2 thinning and 5 pruning plots.
4. Establish (a) one new test of cleaning (b) three pruning demonstrations, (c) one test of poisons for disposal of defective trees.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: Wellner, Helmers.

PLANTING

FIELD DIVISION: Forest Management Research

WORK PROJECT: Regeneration

LINE PROJECT: Planting

PURPOSE OF WORK: To develop methods of reforestation.

REVIEW OF PAST WORK: Investigative work in planting and nursery practice started with the establishment of Savenac Nursery and Priest River Station and continued intermittently until 1926. Nursery studies in seedbed densities, season of sowing, and root pruning reported in numerous publications contributed much to the development of nursery practice. These practices were summarized in 1930 by Administration in U.S.D.A. Circ. 120, "Growing Trees for Forest Planting in Montana and Idaho." Studies in direct seeding conducted between 1915 and 1921 did not develop a successful method. Results of planting investigations contributed to the development of a successful planting technique and indicated that transplant stock was better than seedling stock and that season of planting had no appreciable effect on survival. However, an analysis of plantation survival records, 1910-1936, inclusive, showed that spring-planted stock survived better than fall-planted stock and that average survival 10 years after planting was only 42 percent. To determine where improvements in planting practice might be made, investigations were resumed in 1936. A 5-year study of grade and age, class of stock, carefulness in planting and handling stock, and early, middle, and late spring planting was started, with the station and the regional office cooperating, and was continued by the planting office with occasional help and advice from the station. Since 1937 the station has concentrated its efforts on investigations of direct seeding. Results of this work are as follows: (1) Western white pine, ponderosa pine, and Douglas-fir were successfully seeded on selected sites when protected from rodents. (2) In several large-scale trials satisfactory rodent control was obtained using a poisoning method developed by the Fish & Wildlife Service. (3) Fall sowing was superior to spring sowing. (4) Cultivation of ground prior to sowing on recent burns had no effect on germination and survival. (5) Sowing in prepared spots was cheaper than broadcast sowing. (6) Western redcedar, a small-seeded species, was successfully seeded on selected sites without rodent protection. (7) Stocking of Engelmann spruce, another small-seeded species, was generally better where the seeds were given protection from rodents. (8) Seeding promises to cost about the same or less than planting.

ACCOMPLISHMENTS DURING PAST YEAR: Direct seeding tests were continued as follows: (1) Survival was recorded on 4 plots and effects of thinning seed spots was measured on 4 other plots. (2) All plots

were maintained and marked so that future measurements could be made at 5-year intervals rather than annually. (3) Three station research notes, as follows, were published covering the results of the tests to date: "Fifth year results of direct seeding with western redcedar and Engelmann spruce," Research Note No. 42; "Direct seeding western white pine - fifth year results," Research Note No. 44; "Results of direct seeding ponderosa pine," Research Note No. 46. (4) A manuscript prepared in 1941 for Departmental publication titled "Seeding as a means of reforestation in the northern Rocky Mountain region" was revised, new material added, and transmitted to Washington for editorial review and publication. A paper, "Direct seeding experiments in the Inland Empire," was submitted to Northwest Science for publication.

The results reported may be summarized as follows: Successful seedings were obtained only on freshly-burned north slopes and flats within the western white pine type.

PLANS FOR 1947: The initial establishment phase of direct seeding studies is completed. Hereafter, these tests will yield information on growth and development of seeded stock. Measurements will be made at 5-year intervals.

Work during 1947 will consist of (1) Preparation of report on results of thinning seed spots. (2) Measurement of 10th year growth and mortality on 4 direct seeding plots. (3) Measurement of growth and mortality on one plot testing planting of white and ponderosa pines, pure and in mixture, on a south facing slope within the white pine type. (4) Establishment of one test of plantation release. (5) Cooperate with J. Moss, Bureau of Entomology and Plant Quarantine, on seeding of pregerminated seed.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: Helmers, Wellner, Roe. (Cooperation, V. D. Moss, Office of Blister Rust Control.)

January 1947

GEOGRAPHIC STRAINS

FIELD DIVISION: Forest Management Research

WORK PROJECT: Genetics

LINE PROJECT: Racial Variation (geographic strains of ponderosa pine)

PURPOSE OF WORK: To determine suitability of ponderosa pine seed from different sources for planting in northern Idaho; to ascertain heritable characteristics of growth, form, and hardiness developed through adjustment of parents to local climate.

REVIEW OF PAST WORK: Trees grown from seed of ponderosa pine collected in 21 widely separated localities in western United States were planted in plots at the Priest River Experimental Forest from 1911 to 1917. Plots studied and reported upon by Kempff in 1927. Thorough field examination and measurements made in fall of 1935 and analysis made by Weidman. Differences with respect to number of needles to the fascicle, length of needles, general appearance of foliage, and thickening of hypoderm found among progeny groups derived from different regions delimited on the basis of precipitation type. Persistence of needles found not to be hereditary. Pronounced differences found among different progenies in height growth, diameter growth, relation of two, and relative height growth by years. Best growth in height and diameter made by trees derived from localities which in climate resemble locality of planting site. As sources of seed for planting in northern Idaho, experiment indicates trees of North Pacific region unsuitable because of low frost resistance, those of Black Hills and southeastern Montana questionably suitable because of early decline in growth rate, those of Central and South Plateaus and Colorado decidedly unsuitable because of distinctly poor rate of growth. Findings to date indicate most suitable general territory in which to collect ponderosa pine seed for northern Idaho use extends from Colville locality in Washington eastward a little beyond Continental Divide and from Salmon River to Canadian boundary. Manuscript "Evidences of Racial Influence in a 25-Year Test of Ponderosa Pine" by R. H. Weidman published in the Journal of Agricultural Research, volume 59, number 12.

ACCOMPLISHMENTS DURING PAST YEAR: Plots remeasured.

PLANS FOR 1947: None. Data will be analyzed and another progress report prepared in about 1956.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: Helmers.

January 1947

STAND IMPROVEMENT - LODGEPOLE PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Stand Improvement (Lodgepole pine type)

PURPOSE OF WORK: To develop stand improvement methods which will improve the quality and growth of immature stands.

REVIEW OF PAST WORK: This is a new project with no record of past work. A few thinnings were established in young lodgepole pine stands during the CCC period by National Forest officers, but there are no records of results. The new lodgepole pine transmission pole, pulpwood, and sawlog sales have created the first opportunity to conduct stand improvement on a systematic basis with sale area betterment funds. The most striking stand improvement needs in this type are reductions in density of young stands, and the control of dwarf mistletoe.

ACCOMPLISHMENTS DURING PAST YEAR:

PLANS FOR 1947: In cooperation with Deerlodge National Forest, establish some experiments for the control of dwarf mistletoe in badly infested reproduction on the Phillipsburg District.

ASSIGNMENT: LeBarron, Roe. (Cooperator, District Ranger R. J. Bowers.)

January 1947

HARVEST CUTTINGS - LODGEPOLE PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Harvest Cuttings (Lodgepole pine type)

PURPOSE OF WORK: To develop methods of cutting, soil preparation, and slash disposal that will insure (1) satisfactory regeneration of desirable species, and (2) the largest returns of useful timber products, consistent with regulation of streamflow.

REVIEW OF PAST WORK: Between 1906 and 1915 extensive timber sales for mine products made by the Forest Service in vicinity of Butte and Anaconda. Studies conducted by Region One at that time, reported in two Department Bulletins (Nos. 154 and 234), indicated desirability of a rotation of 140 years, clearcutting over-mature stands, selective cutting generally of the larger trees in mature stands, improvement thinnings in immature stands, and disposal of slash by piling and burning. Recent studies by Rocky Mountain Forest and Range Experiment Station in Colorado indicate that snow accumulation is increased by heavy or clearcutting, but point out desirability of preserving a patchy distribution of timber cover to retard evaporation and spring melting.

ACCOMPLISHMENTS DURING PAST YEAR: Widespread observations, with assistance of Timber Management and National Forest personnel showed that dwarf mistletoe infections are general and heavy; that reproduction which has originated in thinned out stands is usually heavily infected. It is not known how damaging dwarf mistletoe may prove to be on small saplings, but it possibly is far more destructive than on larger trees. When more has been learned about the effects of the disease, it may have a profound influence on cutting practices. For example, it may rule out heavy improvement cutting as a sales practice. It may point to clearcutting or broadcast burning in infected stands. A small study was begun with aid from Deerlodge National Forest personnel to gain more knowledge about the development of the disease. A small trial of the use of the lethal plant hormone, 2-4D, gave unsatisfactory results. Dosages which apparently killed the mistletoe plants also were very damaging or fatal to the host trees.

Timber sale areas and prospective sale areas were visited on the Lewis and Clark, Beaverhead, Deerlodge, and Helena National Forests and a limited amount of advice and guidance on cutting practices was given.

January 1947

PLANS FOR 1947: Continue to provide advice on cutting practices and assist Deerlodge National Forest in planning an examination of old cuttings.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: LeBarron, Roe, Boe. (Cooperator, A. E. Squillace, Deerlodge National Forest.)

January 1947

STAND STUDIES - LARCH-DOUGLAS-FIR

FIELD DIVISION: Forest Management Research

WORK PROJECT: Mensuration

LINE PROJECT: Stand Studies (Western Larch-Douglas-Fir Type)

PURPOSE OF WORK: To determine composition, growth, mortality, and yield of stands of the western larch-Douglas-fir type.

REVIEW OF PAST WORK: 1. Measurement of increment and mortality 25-35 years after cutting on 86 temporary plots in selectively cut stands. Most of office compilations made and preliminary report issued.

2. Four permanent yield plots established during last 25 years in fully stocked natural stands.

3. Yield study of even-aged stands made by forest survey taking data on 150 temporary plots. Of these 42 have been selected for remeasurement as semi-permanent yield plots.

ACCOMPLISHMENTS DURING PAST YEAR: None.

PLANS FOR 1947: Review earlier work on growth of cut-over stands and consider reopening this study. The cut-over area surveys described under Harvest Cuttings will be partly Stand Studies functions.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: LeBarron, Roe, Boe.

January 1947

HARVEST CUTTINGS - LARCH-DOUGLAS-FIR

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Harvest Cuttings (Larch-Douglas-Fir Type)

PURPOSE OF WORK: To develop methods of stand management that will bring about (1) maximum production of desired products and a minimum of mortality losses, and (2) adequate regeneration of desired species.

REVIEW OF PAST WORK: This is a new project. Little or no experimental work has been conducted, either here or in other regions in this type. Experimental work in the western white pine type has shown that larch is less shade-tolerant than Douglas-fir. Larch is known to be longer-lived and grows to larger sizes. Both species commonly are infected with dwarf mistletoe - sometimes to a seriously damaging extent. Recommendations for the larch-fir type in "Timber Growing and Logging Practice in the Western White Pine and Larch-Fir Forests of the Northern Rocky Mountains," Department Bulletin No. 1494, and Region One marking rules; which are based upon observations and considerable experience over a long period of years, provide for a seed tree or light shelterwood type of cutting which is intended to give larch the best opportunity to regenerate and leave a comparatively few selected trees for further quality and size increment. Recently the Kootenai National Forest has proposed adoption of a selection system of cutting which will remove approximately 70 percent of the volume at 60-year intervals.

ACCOMPLISHMENTS DURING PAST YEAR: None

PLANS FOR 1947: Commence systematic examinations of old cuttings to obtain information on regeneration following cutting and the response of residual trees. This work will be conducted concurrently with similar studies in the ponderosa pine type which blends into the larch-Douglas-fir type.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: Roe, Boe.

January 1947

STAND IMPROVEMENT - PONDEROSA PINE

January 1947

FIELD DIVISION: Forest Management Research

WORK PROJECT: STAND STUDIES - PONDEROSA PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Mensuration

LINE PROJECT: Stand Studies (Ponderosa Pine Type)

PURPOSE OF WORK: To determine composition, growth, mortality, and yield of stands of the ponderosa pine type.

REVIEW OF PAST WORK: A total of 186 temporary yield plots established in even-aged stand during the period 1932-34 as part of an inter-regional growth study. Data turned over to the Pacific Northwest Station which prepared technical bulletin No. 630, "Yield of Even-Aged Stands of Ponderosa Pine" in 1938.

ACCOMPLISHMENTS DURING PAST YEAR: None.

PLANS FOR 1947: The cut-over area studies described under Harvest Cuttings will be partly Stand Studies functions.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: LeBarron, Roe, Boe.

January 1947

STAND IMPROVEMENT - PONDEROSA PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Stand Improvement (Ponderosa Pine Type)

PURPOSE OF WORK: To develop stand improvement methods which will improve the quality and growth of immature stands.

REVIEW OF PAST WORK: 1. Twelve plots to test different intensities of thinning established on the Lolo National Forest during 1933 in a 50-year-old ponderosa pine stand. Fifth-year remeasurement of these plots showed that ponderosa pine responds well to thinning. Greatest response was obtained in heavily thinned plots. Results, shown by fifth-year remeasurement, summarized and issued as station research note number 3.

2. Three additional thinning plots established on the Lolo National Forest in a 30-year-old stand during 1935.

3. Test of pruning ponderosa pine to determine yields of lumber grades of paired pruned and unpruned trees established on the Priest River Experimental Forest.

4. A plot to determine the relationship between pruning and subsequent wood rot infection established on the Priest River Experimental Forest during 1940.

5. A crop tree pruning plot and check plot established on the Lolo National Forest in a 50-year-old ponderosa pine stand in 1933.

ACCOMPLISHMENTS DURING PAST YEAR: Research Note No. 45 entitled, "Pruning Wound Healing on Western White and Ponderosa Pines" was issued as a result of analysis of the pruning plot established in 1940 on the Priest River Experimental Forest. Study discloses that optimum conditions for rapid wound healing result from close pruning small live branches on rapidly growing trees.

PLANS FOR 1947: None. Third five-year remeasurements will be due on the 1933 plots in 1948.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: LeBarron, C. A. Wellner, Helmers, Roe, Boe.

January 1947

HARVEST CUTTINGS - PONDEROSA PINE

FIELD DIVISION: Forest Management Research

WORK PROJECT: Silviculture

LINE PROJECT: Harvest Cuttings (Ponderosa Pine type)

PURPOSE OF WORK: To develop methods of stand management that will bring about (1) maximum production of desired products and a minimum of mortality, and (2) adequate natural regeneration of desired species.

REVIEW OF PAST WORK: Three plots (Greenough) were established in 1932 to test three types of cutting in a ponderosa pine operation of the Anaconda Copper Mining Company. Types of cuttings were: (1) removal of all saw-timber trees, (2) economic selection, and (3) a heavy improvement cutting. The economic phase of the study has been reported in several publications by the former Division of Forest Products.

Ten-year records since cutting indicate tentatively that: (1) trees classified as of poor vigor have suffered 2 to 12 times greater mortality than good-vigor trees; (2) many of the poor vigor trees that survived the shock of exposure have improved in vigor; (3) diameter growth acceleration of individual trees was greatest on the most heavily cut plot. Reproduction data have been collected but not compiled to date.

A report by James C. Evenden of the Forest Insects Laboratory at Coeur d'Alene, Idaho, issued in 1938 as Applied Forestry Note No. 84, Northern Rocky Mountain Forest and Range Experiment Station, disclosed a very light loss of trees from insect attack in the improvement cut and clear-cut plots, and a very heavy loss on the economic selection plot.

A bulletin entitled, "Timber Growing and Logging Practice in Ponderosa Pine in the Northwest," Technical Bulletin No. 511, was issued in 1936 summing up the work in Ponderosa pine in this region and the Pacific Northwest.

ACCOMPLISHMENTS DURING PAST YEAR: Lick Creek cut-over area survey. One of the earliest Forest Service sales (Lick Creek Sale 1906) in Region One on the Bitterroot Forest involving approximately 2500 acres was selected as the most suitable for an exploratory survey, to serve as an initial step in the study of harvest cuttings in the ponderosa pine type in western Montana.

Objectives of Survey: (1) Sample the results of 35 years growth and mortality following early Forest Service selective cutting. (2) Determine the character, quantity, distribution, and factors affecting

reproduction. (3) Develop leads for planning further cut-over area studies and experimental cuttings. (4) Obtain information that may have immediate application.

Analysis of the field data is under way. Preliminary indications are that: (1) Acceleration of growth for the 35-year period following logging on many individual trees was good. However, growth for the stand as a whole has fallen short of predictions, despite the fact that this area has suffered much lighter mortality than uncut stands on the forest. This shortcoming is the result of: (a) too light a reserve stand upon which to grow additional increment and (b) uneven distribution of cutting over the area which seriously reduced stocking in some sections, whereas trees were given little or no release in others, notably the bull pine groups.

(2) Natural regeneration on the area is good although Douglas-fir is encroaching seriously upon the pine type on certain exposures. Douglas-fir seems to assume the lead over ponderosa pine because it becomes established 5 to 10 years earlier. Perpetuation of a desirable percentage of pine on these exposures will require the removal of advance fir reproduction either by fire, mechanical means, or subsequent improvement work such as cleanings. Advance reproduction comprises the significant trees in the oncoming stand which supports the previous observation of Wiedman in U.S.D.A. Technical Bulletin 511 and others.

Plans and preliminary background work have been completed for a study of the effect of deer browsing on ponderosa pine reproduction.

Working plan for proposed experiments in regeneration of ponderosa pine on the Kootenai National Forest has been prepared. Three types of treatment to be tested are: (1) Prescribed broadcast burn slash. (2) Scarification of soil. (3) Pile and burn slash and plant. Carrying out of experiments is the responsibility of the Forest Supervisor with advice and assistance from Station.

PLANS FOR 1947: (1) Complete analysis of field data and prepare report of Lick Creek cutover area survey. (2) Make third five-year remeasurement of Greenough plots and prepare report. (3) Plan and execute further cut-over area survey on a more extensive system, but following the leads developed from the Lick Creek survey. (4) Carry forward the survey phases of the deer browse study and establish the studies of longer duration; i. e., clipping study. (5) Assist to the extent possible in the regeneration experiment on the Kootenai Forest.

DATE OF COMPLETION: Continuing project.

ASSIGNMENT: LeBarron, Roe, Boe, Adams (Cooperator, J. C. Evenden, Forest Insects Laboratory).